DEVOTED EXCLUSIVELY TO METALLIC SURFACE TREATMENTS

METAL FINISHING

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COMING SOON

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Establishing rates for metal finishing operations using Elemental Time Standards.

A review of the most important developments in metal finishing for the past year.

The hardness of electrodeposited chromium.

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The WASHINGTON OBSERVER

News and Views from Official Washington

George W. Grupp

• Washington of today is very much like it was in 1941. Then we were embarking upon a system of Government controls to channel production and labor for war purposes. Today, in a semi-war period we are invoking Government controls to direct labor and production for United Nations policing service and to provide ourselves with defense materials and equipment.

• In line with the nation's mobilization program the Department of Commerce is making an inventory of small manufacturing firms and shops to help prime contractors of DO orders to find subcontractors.

• The National Production Authority has authorized Canadian companies to use American DO priorities to obtain materials for defense production.

• No orders for direct control of the manufacturing of metal finishing equipment are anticipated by the NPA in the next few months.

• Irrespective of the size of the metal finishing shop, an inventory record of industrial alcohol, benzene, caustic soda, chlorine, glycerine, soda ash, aluminum, cobalt, copper, nickel, tin and zinc should be kept, because the National Production Authority has set up a "compliance section" in each of the 42 district offices of the Department of Commerce to enforce NPA control, inventory, and priority orders. Violators of these regulations are subject to fines and imprisonment.

• Every one-man metal finishing shop should not forget that he is now under the Social Security law as a self-employed person, and that he must pay this special tax to the Government with his 1951 income tax.

• Civilian consumption of aluminum, cadmium, chrome, copper, nickel and zinc will be reduced at least 20 to 30 per cent in 1951. Cobalt may be reserved exclusively for defense needs. For this reason manufacturers are making plans to use substitute materials when possible.

• In spite of the increased rate of tin production in 1950 the price of this metal increased from 77 cents a pound in June to $1.36 a pound in November—passing the 32 year high of $1.10 on October 10th. This amazing rise of price of tin is due to various local wars in Asia, federal government stockpiling, and speculation. The Reconstruction Finance Corporation may sell tin at a fixed price of $1.03 a pound to curb the skyrocketing prices of this metal.

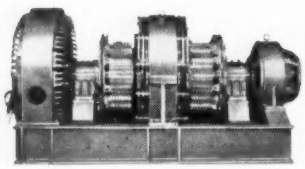
• If the current rate of inflationary tendencies continues the purchasing power of the 1939 dollar will be only worth 35 cents by July 1951. To curb the present momentum of inflation additional measures will be taken by our fiscal and monetary authorities. They may raise short term interest rates and increase the required bank reserves.

• While the "take-home" pay of workers is expected to be higher in 1951, a sharp rise in the cost of living will partially offset this increase.

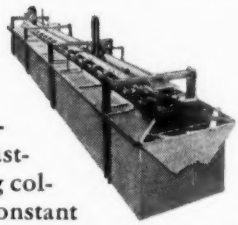
Look

before you leap

when you buy plating and polishing equipment and supplies



Always thoroughly investigate low-voltage generators. Check if brush holders are fully insulated; if longer brush life is assured by a copper pigtail bar which eliminates current passage through springs and fingers. For optimum commutator efficiency, insist on copper graphite brushes, on moulded-in "equaload" shunts for equal distribution of loads and reduction of resistance. Only when all these features are present can you be sure of trouble-free, economical commutation. You'll find them and more in H-VW-M Low-Voltage Generators. Bulletin G-102 describes them.



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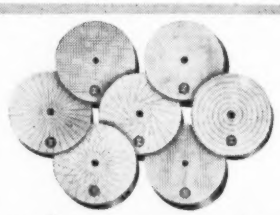

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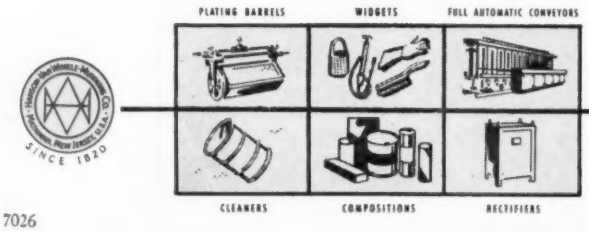

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METAL FINISHING

Honesty Is The Best Policy

In last month's editorial a point was brought up which is of such importance to the plating industry that it is worth emphasizing again. The point involves *letting the customer know when and if an item bears a sub-standard or non-specification plated finish*, either because of metal or chemical shortages, or for any other justifiable reason.

We can be thankful that the average American consumer always has been, and always will be, satisfied with nothing but the best: that goes for plated finishes as well as other things. On the other hand, this same consumer has always been willing, *if properly and accurately informed*, to make the necessary allowances for sub-standard quality in times of any national emergency.

There is nothing to lose, and very much to be gained, by a frank and honest admission that a certain known sub-standard plated finish cannot be expected to give the same satisfaction as a regular high-quality job. The consumer will thank you for it and the plating industry will thank you for it.

The automotive industry in particular, because it is the leading exponent of plated finishes and because failures of automotive plated finishes are so forcibly brought to the consumer's attention, should lead the way in such a program. That it is not doing so is obvious from the fact that more cars are being produced in the last six months of this year, when only a portion of the normal requirements for plating materials are available, than were produced before the plating material shortages became effective.

In looking at a great many of the brand new cars, for instance, we have yet to see or hear anything to re-assure the poor customer of the true state of affairs. In this case spreading the plating on thin can be even more damaging than the salesman's "spreading it on thick."

W. A. Raymond

Editor

Metal Finishing

Wishes You A Very Merry Christmas and A Happy and Prosperous New Year

Evaluation of Industrial Wastes In Metal Processing Industries

By David Milne, Ch.E., General Motors Corp., Detroit, Mich.

Mr. Milne obtained his B.S. and Masters degree at Wayne Univ., and for 14 years has been associated with the General Motors Corp. as a chemical engineer. He is a registered professional engineer and a member of the American Chemical Society, as well as a special instructor in chemistry at Wayne Univ.

THE operation of metal processing plants for the manufacture of component parts, and for the assembly of these component parts into the finished product, entails the use of certain chemical processes of widely diversified natures. Some of these processes are found necessary to add features of endurance, corrosion prevention, appearance, or strength to the parts or assemblies, and some are made necessary from the standpoint of economy or convenience. For instance, in many places it is considered economical to generate acetylene in the plant for welding purposes, rather than to purchase the bottled gas. The generation of this acetylene is, of course, a simple chemical process in which calcium carbide is immersed in water, thus generating the gas, and leaving slaked lime or calcium hydroxide as a by-product and waste. Again, the operation of electro-plating systems gives rise to many waste discharges of a highly detrimental nature.

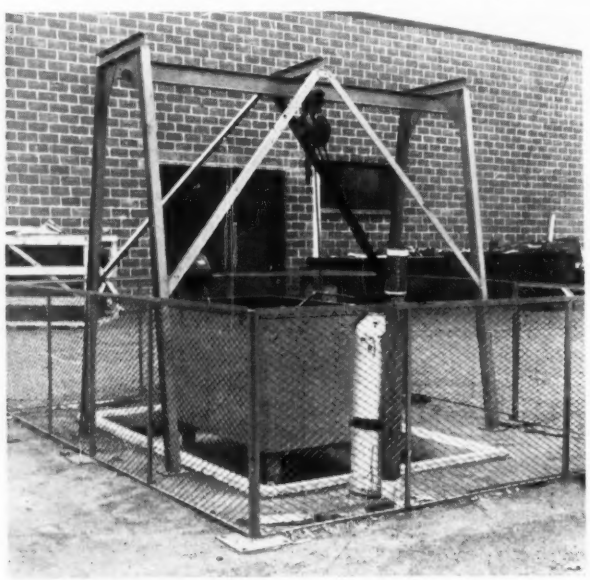


Figure 1. Simple chlorination set-up at Detroit Diesel Div., General Motors Corp., for destruction of cyanides from heat treatment wastes.

The plant engineer in such an organization is frequently given the responsibility of evaluating the pollution potential of the wastes discharged from his plant, and, in the absence of chemically trained help, sometimes has difficulty in determining the significance of some of the materials wasted. It is entirely possible, therefore, that a particularly obnoxious waste might be overlooked, or considered unimportant, in the usual plant survey, while conditions in the receiving stream or sewage plant are gradually deteriorating to a point where embarrassing action or publicity might result. The opposite condition might also exist, in which the conscientious plant engineer attempts to develop a waste treatment program to cover all of the materials he considers harmful. Without competent chemical advice the tendency would be to build a large installation which would not only be bigger and more expensive than necessary, but would not take advantage of the natural chemical possibilities of the situation. The question arises quite naturally, therefore, as to what are the sources and characteristics of the waste materials from metal processing plants.

With this situation in mind, a compilation of the various waste products from a metal processing plant, together with some indication of their pollution potential, should be of considerable interest to the plant engineering staff. It is the purpose of this article to describe the various waste liquids discharged from this type of manufacturing operation, to identify those ingredients which would be considered injurious, to estimate the degree of treatment necessary, and to list the methods commonly used for eliminating the objectionable character of the waste. No attempt will be made to describe treatment methods completely, but, on the other hand, sufficient reference will be made to articles describing these methods to enable the plant engineer to study the more important, practically-proven methods.

Minimizing Waste Discharge

It should be emphasized that, before embarking on a program requiring the construction of expensive treatment apparatus, every possible step should be taken at the source to eliminate or minimize the waste discharge. In most cases, every pound of chemical discharged to waste must be replaced in the process at the full market price of the material. *The easiest, cheapest, and most*

efficient waste control process is that which eliminates the waste itself.

In general, this may be accomplished by the following procedures, the choice of which will be governed by the situation at hand and the economics involved:

1. In the case of unintentional or careless waste discharge establish proper supervision and control. Be sure that the man actually working with the material is educated in the necessity for saving it and made aware of the bad effects resulting from careless waste.
2. Where rinsing processes are involved, determine the advisability of reducing the quantity of rinse water used. Where excessive rates of rinse water flow are made necessary by high drag-out due to peculiar part construction, use any device within the limits of economy and convenience to minimize this unnecessary waste. Many solutions being lost in this way cost a lot of money when chemicals, heat, and labor are considered.
3. In the case of cooling waters, which are often wasted unnecessarily, determine the possibility of heat recovery and re-use of the water as solution makeup or service supply.
4. Modify the process to permit the use of a different chemical agent which will produce the same results for the same or preferably less overall cost. Overall cost in this case should include cost of waste treatment if such is necessary. (Example—Can an acid copper plating bath be used instead of a cyanide copper where disposal of cyanide is a problem?)
5. Substitute an entirely different process for the one in use. Naturally, this new process must accomplish the same results at the same or less overall cost. [Example—Can a shot cleaning process be used instead of acid pickling? New developments in this field offer considerable promise of this. (11, 28)]
6. Purify or recondition by either chemical or mechanical means, and continue to use the solution. [Example—Treatment of emulsified cutting oils by both mechanical and chemical processes may prolong the emulsion life for years. (23)]
7. As a last resort, investigate the possibility of selling the waste to some other nearby industry which may be able to use it in their process. (An acid pickling waste problem was solved at one plant when it was found that a neighboring firm needed a cheap source of dilute sulfuric acid for manufacture of fertilizer.)

The next step in establishing a waste control system is to investigate the chemical nature and volume of the materials being discharged. This may have no relationship to the composition of the solutions at the time they are prepared, but should include only the actual composition at discharge including the impurities which made discharge necessary. This step should be performed under the supervision of competent chemical personnel experienced in both industrial waste control and the process involved, so that the magnitude of only the significant polluting elements may be determined.

With respect to waste treatment processes, it should be pointed out that as a general rule those processes

Figure 2. Holding and dilution system for plating wastes installed at Aeroproducts Div., General Motors Corp. Strong solutions are retained in basins near control house and bled into dilute effluent settling basins in foreground.

requiring the addition of a chemical agent to convert a material from a toxic to a non-toxic form are more expensive than those requiring simple mechanical handling. This is obviously due not only to the cost of the chemicals involved, but to the high cost of supervision and the caliber of the personnel required. Relatively cheap labor can be used and trained in the operation and control of simple mechanical devices. On the other hand, well-trained technicians and professional supervision are usually required for the chemical treatment systems.

One further cautionary note is advisable. One frequently hears the statement that "an acid waste may be neutralized by adding an alkali or by mixing with an alkaline waste." From this the plant engineer may be led to believe that *any* acid waste can be treated and made harmless by the addition of *any* alkali-containing material. This will be true in most cases, but when the treatment of a material such as chromic acid is indicated it will be found that simple neutralization is far from being an adequate treatment. Other unexpected chemical factors sometimes enter into an apparently simple situation to complicate matters in an embarrassing fashion, and the advice of competent chemical personnel should be secured before a final decision is reached on treatment methods.

Types of Wastes

The following information represents a fairly comprehensive survey of the waste liquids discharged from metal processing plants. As far as possible, the waste is classified under the operation from which it is derived, to permit ready identification of the source.

Acetylene Generation

The slurry discharged from the acetylene generator at the end of the generating cycle is usually retained in a settling basin. The solid particles are permitted to settle out, the clear liquid then being decanted off. In most plants the slurry is then removed by tank truck to the nearest dump. In some cases, however, the slurry discharge from the generator is allowed to enter the sewer directly, which ultimately results in a plugged sewer either on or off the plant property.

It is generally estimated that one pound of calcium carbide will form 1.35 pounds of dry lime, or roughly 9 pounds of wet lime sludge. The solid matter dis-

charged is a high purity calcium hydroxide, or hydrated lime, often assaying over 97% available lime. The liquor is a saturated solution of the lime and will contain about 0.18% calcium hydroxide at room temperature.

This material is not particularly harmful except for the pH value of its solution (around 12.4) which would be too high for satisfactory compliance with most industrial waste ordinances. As indicated above, it may be disposed of by dumping, if necessary. Its alkaline character however, makes it useful as a cheap neutralizer for acid wastes. Some possibility exists of using the material as a soil conditioner and as a water softener, and recent investigations have pointed to its satisfactory use as a sewage sludge conditioner.[4, 5, 19]

Cleaning

Acid Dips. Some operations require the previous removal of thin films of corrosion products such as rust. This is frequently done by immersion in acid dips containing dilute solutions of sulfuric, hydrochloric (muriatic), nitric, or phosphoric acids. The phosphoric acid dip also leaves a film of metal phosphate on the surfact of the part which may be desirable for certain applications. The significant character of these solutions lies in their high acid content and in their metal content at the time of dumping. The acid constituent attacks and eventually ruins sewer structures, which may necessitate expensive replacement. The metal content of the solution, when discharged to a stream, results in the gradual formation of a visible sludge cloud in the water.

Composition of the waste acid will vary widely with the installation, and no dependable average figure can be quoted for these wastes. Water from a rinse tank following the acid dip will have a considerably lower concentration, but will be discharged over a longer period of time.

For the protection of sewer equipment these wastes should be neutralized before dumping. Simultaneous dumping of an alkali cleaning solution containing at least an equivalent amount of alkali should help this situation in the case of discharge to a municipal sewer, provided the city ordinance permits the amount of sludge developed. Some cities have found that, with sufficient dilution water, the sludge developed by this process would be acceptable in the sewers, and that sewage plant operations are sometimes aided by the sludge included. Where discharge is made to a stream, neutralization and settling for sludge removal is essential.

Further information is given on this subject under Pickling.

Alkali Dips. The used cleaner will contain various combinations of sodium hydroxide, sodium phosphates, carbonates, silicates, and soaps, together with some suspended dirt and emulsified or floating oil. The alkaline materials in these wastes are not particularly harmful, but the oily matter will be found highly objectionable and undesirable in both water courses and sewage plants.

Quite frequently the useful life of these cleaners can be extended by adding a soap such as sodium resinate to replace that lost during operation.

The waste may be of some value as a treatment agent for an acid waste. In this case provision should be made in the treatment apparatus to remove both sludge and floating oil.

Rinse waters from alkali cleaners will rarely require treatment.

Cyanide Dips and Neutralizers. Some operations call for the use of a cyanide dip or neutralizer as part of the cleaning cycle. The cyanide dip itself may contain a sodium cyanide concentration varying from 0.3 to over 6 ounces per gallon, depending on the process. Sodium cyanide from these dip solutions can cause considerable trouble both in sewage treatment plants and in streams. Due to the extremely poisonous nature of the material, its discharge without proper treatment will result in the killing of fish and other wild life, and may cause death to livestock drinking from a stream. This may happen even after treatment by the normal sewage plant processes, so the fact that plant effluents are passed through a municipal sewage treatment plant is no guarantee of safety in this respect.

Unless tremendous volumes of dilution water are available, and satisfactory equipment provided for thorough mixing, the cyanide wastes should not be disposed of by dilution, but should be subjected to chemical destruction. Methods available for this include the alkali chlorination process, the lime-sulfur treatment, decomposition by acid followed by aeration, and the electrolytic oxidation treatment.[7, 8, 14, 22, 26]

Emulsions. Cleaning operations are sometimes conducted by immersion in emulsions composed mainly of kerosene or mineral oils, or by spraying the parts with such a mixture. The oiliness of these materials makes them particularly objectionable to sewage treatment plants and to streams, since none of the natural processes will completely destroy the oils. In the case of sewage treatment plants, equipment becomes fouled, sludge digestion inhibited, and proper operation of trickling filter plants interfered with. In the streams, besides the objectionable film of oil on the surface, the bottom plant life, on which the entire life cycles of the stream fauna depend, is killed by a sticky, oily, film.

Disposal of these wastes should be to a suitable treatment plant for removal of the oils before discharge. This treatment plant may be a formal type requiring chemical coagulation and settling (see sections under Oil Emulsions), or it may be a simple filter built of coke. The coke adsorbs the oily matter, and when used up, may be burned in the furnace. Some consideration might also be given to discharging occasional batches directly to the coal pile.

Salt Baths. Immersion of parts to be cleaned in baths containing molten salts has been resorted to frequently in the last decade, the Hooker "Virgo," du Pont "Sodium Hydride," and Kolene processes being representative of this type of treatment. Wastes from these cleaning processes will consist of acid dips (sulfuric or muriatic acids) and rinses, and water quenches and rinses of a high alkali and possibly nitrate content, following the hot salt treatment. Disposal of these wastes should present no great difficulty, since ample neutralization as previously outlined should suffice.

Cooling Waters

One of the most frequently overlooked wastes in an industrial plant is the overflow from cooling water

systems such as the systems in use for cooling welding equipment, air compressors, dynamometers, diesel engines, etc. These waters, especially when confined in circulating systems, are subjected to treatments with materials which can be toxic in water courses, and which can be detrimental to sewage treatment processes. Normally these waters will be treated with combinations of chemicals containing chromates, phosphates, tannins, copper compounds and chlorinated hydrocarbons intended for the destruction of algae growths. The copper compounds are normally applied in very small quantities and will ordinarily represent no great hazard in the quantities discharged from the normal circulating system. Chromates, however, are applied in concentrations varying from about 150 ppm to over 2,500 ppm, and in these cases the possibility of pollution from the overflow should be considered. Systems being treated with phosphates present no hazard whatsoever from the waste disposal standpoint, and those in which the chlorinated hydrocarbons are used, such as Santobrite or Dowicide, will in the usual application present little or no difficulty from the standpoint of toxicity.

Quite frequently these systems are operated from reservoirs or tanks in which the water level is maintained at the overflow point during operation. Shutdown of the equipment overnight usually results in a considerable backflow of solution from the lines, and from any spray tower equipment connected with it. This backflow immediately raises the solution level over the overflow point, and a considerable quantity of the chemically treated water is wasted in this fashion. This represents not only an unnecessary loss in chemically treated water, but in some cases presents a pollution hazard. Careful consideration of the entire circulating system will frequently point out the fact that operation of the reservoir at a lower water level will permit retention of all the backflow water at the end of the operation. The reservoir is usually in use simply as a reservoir and not as a cooling chamber. Therefore, the total volume of liquid in the tank is of no consequence, provided sufficient head exists over the suction inlet of the pump.

Electroplating

The solutions obtained from electroplating processes contain varying quantities of heavy metals and of toxic salts. They are divided into two classifications, the plating solutions themselves and the rinse waters following the plating operations. Cleaning tanks used in connection with plating operations will not be considered in this section, but are discussed elsewhere. (See Cleaning.) In general, the rinses from the plating operations will contain any or all of the metals and radicals indicated during the discussion of the plating solutions. The method to be used in disposal of these rinses will depend entirely on the concentration of the materials in the rinse. In some cases it may be found that dilution will suffice to bring the concentration of the toxic materials to a reasonable level. In other cases, such as the solutions containing cyanides, it will be found that dilution is an uncertain and inadequate method of handling and that some treatment process will be necessary. Treatment of these solutions will mainly be directed towards removal of the cyanides, chromates and heavy metals involved.[1, 3, 10, 17, 27]

The plating solutions to be found in most of the automotive industries will be as follows:

1. *Copper.* The copper plating systems may be divided into three separate chemical types and discussed separately.

   A. *Acid Copper.* The chemical solutions in use here are composed mainly of copper sulfate and sulfuric acid. The predominant features of this solution are then the heavy metal concentration and its strongly acidic nature. Treatment will involve removal of the copper and neutralization of the acid. The copper may be removed in several ways depending entirely on the quantity involved and the economy of the operation. Some consideration may be given to recovering copper as a metal for use as the anode in plating operations. The copper may also be recovered by precipitation and further converted into usable form by chemical treatment. Copper may also be removed from these solutions by passage over finely divided steel turnings or chips or by a similar process using brass turnings.[25] The copper enriched material resulting from these processes is usually salable.

   B. *Ammonia Copper.* These solutions contain considerable quantities of ammonia and phosphates in addition to the high copper content. They are predominantly alkaline and should be handled as a simple neutralization process. The objectionable feature of the solution is its high copper content, which may be treated or recovered as indicated in the acid copper section. If a neutralization process is used, the copper will be removed by precipitation. Some consideration must then be given to conversion of the copper sludge into a usable or salable form.

   C. *Cyanide Copper.* These solutions are strongly alkaline in nature, but their most objectionable feature lies in the high concentration of copper and cyanide in the liquid. The highly poisonous nature of the cyanide, together with the growing tendency to restrict its concentration in plant effluents to one part per million or less, makes it necessary to treat these wastes for the destruction of the cyanide. Under proper conditions removal of the cyanide will at the same time result in precipitation of the copper as a sludge, which may be removed for disposal or recovery as the situation dictates. The more common methods available for destruction of cyanide have been listed previously under Cleaning — Cyanide Dips.

2. *Nickel.* The nickel plating solutions contain quantities of nickel chloride or sulfate, boric acid and other materials of a highly buffering nature. No great difficulty should be experienced with these materials if discharged in reasonable concentrations. Some investigations have indicated that low

(*Continued on page 76*)

Electroplating on Aluminum

By R. H. Keller, F.M.T.C., *Defense Research Laboratories, Maribyrnong, Australia*

Introduction

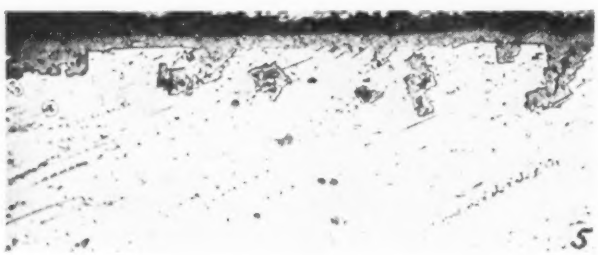
"THE question of electrolytically depositing metals on aluminum has been practically solved by the Pittsburgh Reduction Co. and in a short time the company expects to do this class of work commercially."[1] One would expect this to be a fairly recent statement, but it appeared in the *Iron Age* 51 years ago when aluminum was considered to be little more than a novelty. Since that time many new alloys have been developed and most of them can now be satisfactorily plated. Some of these alloys have very complex constitutions and at least 50 different microconstituents are commonly found in them. These, with their different etching characteristics and distribution throughout the alloy, can make plating difficult, as one method may be suitable for plating on one type of alloy, but be quite unsuitable for another.

Aluminum was first produced commercially in about 1860 and, although the first patent for nickel plating aluminum was issued in 1888,[2] cost and scarcity of the metal discouraged extensive plating experiments until the early 1900's. The development of methods for plating on aluminum has roughly followed trends in increased world production and decreased cost of the metal. Further, as more aluminum articles are being produced, more uses are being found for plated ware; one recent investigator claims to know of 300 applications for plated aluminum.

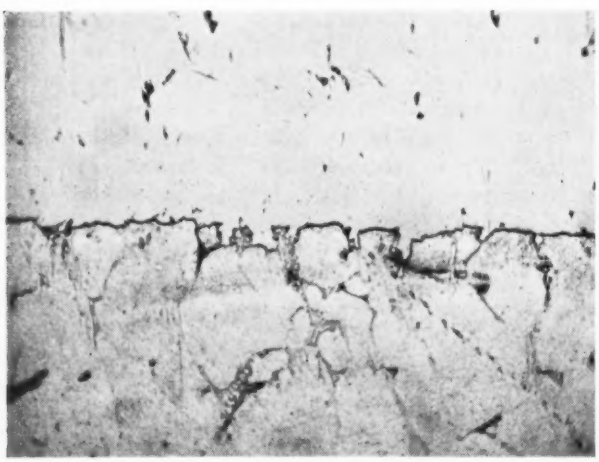
Some of the early workers in this field suggested plating over immersion deposits of cadmium,[3] mercury[4] and tin,[5] but the majority of them believed in severely roughening the surface before plating to provide mechanical "keying" (see Fig. 1) or "interlocking" of the electroplate with the basis metal such as is obtained with the "metal dips." One electroplater, *Thomson*[6], said that in 1908 he used a method whereby he plated an aluminum surface with copper. A copper anode embedded in a brush soaked with copper sulphate solution was rubbed over the metal. A gritty material, such as powdered glass, was worked between the anode and the aluminum surface. This treatment, he claimed, removed the oxide film and plated the first thin copper deposit on a clean surface. Some workers believed that alloying between the plated metal and the base metal was essential for good adhesion. Expensive heat-treatments such as heating for 30 minutes at 430°C. (800°F.) or for 10 hours at 240°C. (465°F.) were consequently employed for this purpose.[6]

Few, if any, methods of pre-treatment used before 1925 gave deposits which could stand up to bending,

Figure 1.



(a) Nickel plate on 2 S aluminum.



(b) Chromium plated aluminum (Y alloy). Note effect of etching on different micro-constituents.

Table 1

ELECTROCHEMICAL SERIES OF THE METALS

(Based on The Metals Handbook 1948 and Handbook of Chemistry 1941)

Electro-Positive	Normal Electrode Potential (volts)
Sodium	2.72
Magnesium	1.55
Aluminium	1.33
Chromium	0.56
Zinc	0.76
Iron	0.44
Cadmium	0.40
Nickel	0.23
Tin	0.14
Electro-Negative	
Copper	-0.34
Silver	-0.80
Gold	-1.36

Table 2

MEAN COEFFICIENT OF EXPANSION OF METALS

Metal	X 10^{-6}
Chromium	7
Steel	12
Nickel	13
Gold	14
Copper	17
Brass	19
Silver	19
Aluminium	25
Zinc	26
Tin	27
Cadmium	31

heating and cooling, or long-service wear. When reviewing advantages of plated aluminum, *Work* in 1927 mentioned that, "it is fortunate that nickel is the usual metal plated, as the two metals are so nearly the same color, worn spots being less perceptible." This certainly does not seem to be a compliment to platers of the period.

Methods of plating on aluminum in use today employ either an immersion coating, "keying" of a deposit, or anodizing and plating on the oxide film. Of these methods, this paper will deal most thoroughly with the widely used zinc immersion plating method.

Difficulties of Plating on Aluminum

The main difficulties encountered when plating are associated with:

(a) Reactivity of Aluminum

As seen from Table 2, aluminum has a high position in the electromotive series of the elements. A metal inserted in a solution of a salt of a less electro-positive metal will replace that metal in solution. Thus, aluminum in copper, silver or nickel salt solutions will dissolve and deposit a loose layer of copper, silver or nickel. A cleaned aluminum surface in such an electrolyte will dissolve unless an electrical contact is made before immersion.

(b) The Oxide Film

The oxide film, which forms spontaneously in contact with air, prevents contact between the underlying metal and the plated coating. This would not be very serious where adhesion depended solely in "keying," but where "atomic adhesion" is aimed for, the occurrence of such a film is deterimental to adhesion. The best adhesion of a plated metal to a basis metal is obtained when the plated metal continues the crystal lattice of the basis metal, even if only for a small distance. Chromium has been said to have good adhesion when plated directly on to aluminum because of a similarity in their crystal lattices.[7] Differences in expansion of the composite metals when heated cause the chromium to fracture and peel when heated to only 200°C. (390°F.).[8] Zinc, copper and nickel with intermediate co-efficients of expansion (see Table 2) are able to overcome this shortcoming.

(c) Porous Castings

Solutions are likely to be trapped in the pores of a casting, leading to blistering after plating. Thorough rinsing, however, will remove these entrapped solutions.

(d) Micro-Constituents

The large number of constituents likely to be present in the alloys will often lead to trouble through uneven etching.

Uses of Plated Aluminum

(a) Decorative

The scope of decorative plating on aluminum is increasing but, nevertheless, it will not replace anodizing as a cheap mass-finishing method. A brightly plated article has much more "sales appeal" than a dull, anodized one, but where thin-plated decorative coatings are applied to aluminum, pores likely to reach the aluminum are often formed in the plated metal. Corrosion of the aluminum is likely to be accelerated through such pores because aluminum in contact with copper or nickel will corrode before these metals. For this reason, plated aluminum, although it has a better appearance, is less desirable than anodized aluminum in applications where straight out protection is desired.

(b) Engineering

Many metals are being deposited on aluminum for engineering uses in such applications as deposition of copper on aluminum to facilitate soldering, brass for engineering uses in such applications as deposition of bonding to rubber, silver for electrical contacts, tin to reduce friction, zinc on threaded parts to prevent seizing, and nickel and chromium to prevent wear. Chromium plating has been used in such applications as aircraft and motor-boat engine cylinders and other engine parts: nickel plating could probably be extensively used in washing-machine parts.

Table 3

TYPICAL EXAMPLES OF POLISHING MATERIALS AND SEQUENCES OF OPERATIONS

Material	Sequence of Operations	Wheel	Abrasive
Wrought products	Buffing	Sewed muslin buff	Tripoli
	Colouring	Open muslin buff	Vienna lime
Sand-castings	Roughing	Glued rag or felt bob.	No. 60 and No. 90 emery.
	Greasing	Glued rag or felt bob.	No.120 and No.200 emery.
	Buffing	Sewed muslin buff.	Tripoli.
	Colouring	Open muslin buff.	Vienna lime.
Die-castings	Greasing	Felt bob.	No.120 emery.
	Buffing	Sewed muslin bob.	Tripoli.
	Colouring	Open muslin bob.	Vienna lime.
Automatic machine products	Greasing	Felt bob.	No.180 or flour emery.
	Buffing	Sewed muslin bob.	Tripoli.
	Colouring	Open muslin bob.	Vienna lime.

Table 4

COMPOSITIONS OF PROPRIETARY ALKALI CLEANERS SUITABLE FOR PRELIMINARY CLEANING

Type	A Solid	B Solid	C Solid	D Liquid
Composition %				
Anhydrous sodium carbonate	47.5	-	-	-
Sodium metasilicate	25.0	58.0	54.0	3.5
Sodium soap	-	-	-	-
Water	27.5	42.0	39.5	34.0
Chlorinated hydrocarbon	-	-	-	60.0
	100	100	100	100
Suitable concentration range (ozs/gal.)				
Min.	4	2	2	2
Max.	8	4	6	8

Preparation for Plating

It is not intended to deal extensively with grinding, polishing, buffing, etc., but it may be mentioned that several good papers cover methods of preparation[9,10,11] and abrasive composition[12] used for these processes. Table 3[10] shows examples of polishing materials and sequences of operation.

CLEANING

Work buffed with grease compositions should be cleaned by means of emulsion cleaners or vapor-solvent degreasers. Simple vapor degreasers tend to leave a film of solid matter on the surface and those containing compounds such as eythlene dichloride[13] or tetrachlorethylene[14] are recommended. When heavy soap-base press compounds are present, mild alkaline cleaners such as are shown in Table 4 should follow the solvent treatment.[15]

Just prior to plating, a mild alkaline cleaner is essential to remove fingermarks, final traces of grease, and to completely wet the surface. The cleaner may be used either electrolytically (in which case it would need to be low in wetting agent to prevent frothing[16]), or as an immersion cleaner. Silicate-containing cleaners are sometimes recommended, but recent work seems to indicate that adhesion troubles are likely to occur owing to the presence of a gelatinous silica film that is left on the surface. This film can be removed, however, by dipping in a solution containing hydrofluoric acid.[17] Suitable cleaners for use at this stage are shown in Table 5.

Table 5

FINAL CLEANING - RECOMMENDED COMPOSITIONS

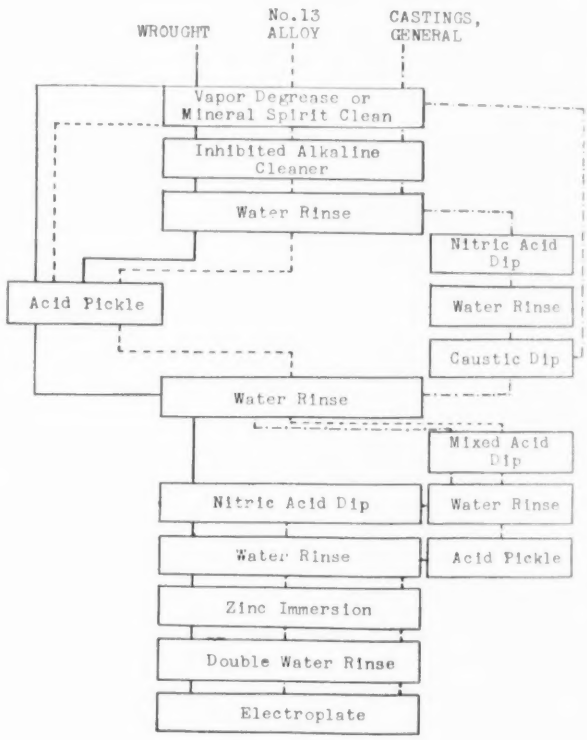
No.	Composition	Type	Conditions of Use		
			Temp.	Time	Other Details
1	Sodium carbonate 3oz/gal. Sodium bicarbonate 6oz/gal.	Non-Electrolytic	93°C	30-60 secs.	
2	Trisodium phosphate 2oz/gal. Sodium metasilicate 3oz/gal.	Non-Electrolytic			
3	Sodium carbonate 2oz/gal. Trisodium phosphate 2oz/gal.	Non-Electrolytic	80°C	1- 3 mins.	Very good
4	Sodium hydroxide 12oz/gal. Sodium carbonate 6oz/gal. Sodium cyanide 0.7boz/gal.	Electrolytic	Cold	1-3 mins.	Work is made cathode at 30-50 amps/sq.ft.

The Zincate Process

Treatment of aluminum articles in a zincate solution prior to plating was described in a 1927 patent;[18] some years later, in 1932, the "Sailerite" process was introduced. In this latter process, the zinc deposit was stripped from the aluminum before plating. Later a German process (FBM) describe the use of a zinc film produced in a zincate bath as a basis for subsequent plating.[19] The process of plating on a zinc film which has been produced in a zincate solution is probably the most widely used method for plating on aluminum.

The effectiveness of the zincate process does not depend on "keying" for the adhesion obtained, but, as will be explained later, it depends on an atomic bond that is obtained between the zinc and aluminum. Table 6[17] shows one suggested treatment to be followed in the preparation of alloys for plating, thorough rinsing being essential between each step.

Table 6



After vapor degreasing, and cleaning in an inhibited alkaline cleaner free from silicates (although one reference[20] recommends the use of such a cleaner preparatory to the zincate pre-treatment) good adhesion may be obtained, for example, between chromium and aluminum by using the following sequence of operations:

(a) CAUSTIC ETCH

A dip in five-per-cent sodium hydroxide is used to remove finger-marks, completely wet the surface and provide some keying. A one-minute dip at 40°C. (105°F.) is usually sufficient when treating most alloys. With some alloys a dark copper smut is left

Table 7

ZINC IMMERSION DIPS

No.	Sodium Hydroxide (NaOH)		Zinc Oxide (ZnO)		Zinc Sulphate ($ZnSO_4.7H_2O$)		Zinc Content	
	oz/gal	gms/litre	ozs/gal	gms/litre	ozs/gal	gms/litre	ozs/gal	gms/litre
1	7.2	45	0.8	5	-	-	0.65	4.0
2	72	450	13	85	-	-	10.4	68.5
3	72	450	-	-	46	290	10.4	66.0

on the aluminum surface but, as this is later removed, it is not a serious objection.

(b) Water Rinse

A thorough rinse is employed to remove traces of the caustic etch. Most references recommend two cold rinses or a cold spray rinse, but the author has found that a hot rinse, used at 70°C. (160°F.) for 10 to 20 seconds is quite effective.

(c) Chrome Pickle

This pickle etches the aluminum surface and removes any scum formed in the alkaline dip. The treatment time is one to two minutes, at a temperature of 65° to 70°C. (150° to 160°F.) in the following solution:

Sulphuric acid (S.G. 1.64) ..... 28 oz./gal. 175 g./l.
Chromic acid ..... 5.5 oz./gal. 35 g./l.

This step may be omitted when plating low-silicon casting alloys without a resulting loss of adhesion, but adhesion will not suffer if this dip is included. When treating commercial aluminum in this dip, 0.000,006 in./minute of aluminum are removed.

Electroplating on Aluminum. Zinc Immersion Process Flow Sheet

(d) Water Rinse

A hot or cold water rinse is used to remove traces of the acid.

(e) Acid Dip

Case 1:—Before the zincate dip, alloys are finally cleaned and lightly etched in nitric acid, a ten-seconds dip in the concentrated acid being adequate.

Case 2:—When a silicate-containing cleaner has been used, it is believed that traces of silica can be carried through to this step and later result in adhesion failures. To remove this silica film, a mixed acid dip is used. This acid dip is also used when silicon-containing alloys are plated.

One such dip consists of a 3:1 mixture of nitric and hydrofluoric acids in which the alloy is immersed until it whitens; this takes about five seconds. This concentrated acid dip is very difficult to store and as an alternative, a mixture of 10 parts of nitric, 10 parts of 48-per-cent hydrofluoric and 80 parts of water by volume may be used. The latter dip is followed by a 50-per-cent nitric acid dip. The weaker mixture (10:10:80) has been found to be more corrosive to aluminum (0.000,009 inches dissolved in 10 seconds), than the concentrated (3:1) dip (0.000,005 inches in 10 seconds), owing to the concentrated nitric acid passivating the aluminum.

(f) Water Rinse

A hot or cold rinse may be used.

(g) Zinc Immersion Dip

The three dips commonly recommended are shown in Table 8. *Bullough* and *Gardam*[21] used solution No. 1 when testing the adhesion of nickel plate on aluminum and they found that the best adhesion was obtained with immersion times of one to three minutes. Unfortunately they did not state their exact working temperature but merely stated that they worked at "room temperature." Experiments as D.R.L. have shown that the effectiveness of the treatment depends very largely on temperature as well as immersion time, particularly when using this dip. The zinc film obtained in this dip usually commences to flake and peel after an immersion time of three minutes at 25°C. (77°F.) and five minutes at 20°C. (68°F.). If, however, the deposit does not blister in the immersion bath, it often does so on rinsing or subsequent plating. Excellent zinc deposits can readily be obtained when either solution No. 2 or No. 3 is employed, even after immersion times of 20 minutes at 20°C. (68°F.) have been used.

Solution No. 3, that made with zinc sulphate, is especially recommended for use on copper-containing alloys,[17] but it is not known why this dip gives better results on such alloys.

The dips are used at about 25°C. (77°F.) with immersion times of two to three minutes. The aluminum is gently mechanically agitated for a few seconds on entering the solution in order to displace the water film on its surface. If conditions of preparation have been correct, a uniformly colored, grey zinc film will form; if not, the deposit should be stripped in nitric acid and the work retreated.

Preparation of Zincate Solution

The sodium hydroxide is dissolved first, then the zinc oxide or sulphate added with stirring. If it appears too turbid, the solution may be filtered through glass wool before use.

$ZnSO_4 + 2\ NaOH \rightarrow Zn(OH)_2 + Na_2SO_4$

$Zn(OH)_2 + 2\ NaOH \rightarrow Na_2ZnO_2$ (sodium zincate) $+ H_2O$.

Action of Solution[21]

The solution is thought to dissolve the aluminum oxide, expose the metal, and deposit zinc thereon.

$Al_2O_3 + 2NaOH \rightarrow 2\ NaAlO_2 + H_2O$.

$3\ Na_2ZnO_2 + 2\ Al + 2H_2O \rightarrow 2\ NaAlO_2 + 3\ Zn + 4\ NaOH$.

The attack on the metal becomes slower after about two minutes dipping, and the total aluminum dissolved is about 0.000,02 inches.

When all of the etches used in the above pre-treatment were taken into account, it was found at D.R.L. that a total of 0.000,10 inches of aluminum were removed from commercial aluminum, and 0.000,16 inches from Y alloy.

(h) Water Rinse

A thorough cold water rinsing is employed.

(i) Copper Plate

With the electrical circuit closed the treated aluminum is introduced into a cyanide copper electrolyte. Copper is deposited over and does not replace the zinc film. With a current density of 20 amp./sq. ft.,

a four to five minute plating time adequately covers the zinc film for subsequent plating. High pH, high free cyanide, and high operating temperatures may all cause blistering of the deposit.[13] The slightly alkaline pyrophosphate copper bath is also said to be satisfactory for plating on the zinc film.

(j) Subsequent Plating

Any of the metals which can be plated over copper can now be deposited. An interesting application is the building up of thick chromium deposits. At D.R.L., chromium deposits up to 0.010 inch thick have been built up by using a copper flash as described, and a thin (less than 0.0005 inch) intermediate nickel deposit. It has been suggested that this is not a satisfactory procedure because of the softness of the underlying deposits, but these deposits are only very thin and should not affect the final thick coating. Aluminum protected against wear in this manner may be mainly from sliding friction or abrasion.

Equipment and Cost

The solutions used in the above pre-treatment method are fairly cheap and easy to store, as shown in Table 8, with the exception of the concentrated mixed acid dip.

Practical Details of Zincate Process
Modifications of the Process

1. The "Alumon" process [22] is one in which the zincate dip is used with the addition of univalent copper salts. This solution is claimed to lead to better results than are obtainable with the plain zincate dip.

2. *Heiman*[23] used the following solution, and he claims that it produces really excellent adhesion, with an immersion time of two minutes at 20° to 25°C. (8° to 77°F.).

Zinc sulphate ($ZnSO_4.7H_2O$)	720 g./l.
Hydrofluoric acid (48%)	35 ml./l.

Other Processes

The pre-treatment methods which will be dealt with in this section are:

Pre-Plate Anodizing

This method of pre-treatment consists of initially forming an anodic film, which is the basis of subsequent plating. In one method the anodic film is "modified" before plating, and in the other metal is plated directly on to the anodized metal. These methods may be further subdivided as shown below.

(a) *Plating on Modified Film*

1. Modification effected by treatment in plating bath. (*Elytal* Process.)
   Anodic film produced in plating bath. (See paragraph 1a below.)
   Anodic film produced in separate anodizing bath. (See paragraph 1b below.)
2. Modification effected by treatment in a special solution. (*Krome-Alume* or *Travers* Process.)

(b) *Plating on Unmodified Film*

1. Anodic film formed electrically.
2. Oxide film formed chemically.

Plating on the Modified Film

The anodic film may be treated before plating either by cathodic reduction in the plating bath, as in the Elytal process, or by dipping in a "modifying" solution such as sodium cyanide in the Krome-Alume or Travers process. These methods will now be dealt with in turn.

(1) *In the method involving cathodic reduction* in the plating bath, the anodic film that is first produced may be obtained by either treating the aluminum in the plating bath itself or by treating it in a separate anodizing bath.

(a) *Anodizing in the plating bath*

As an example of this treatment[24] the aluminum is treated anodically at 30 to 40 volts A.C. in a double cyanide brass bath for two minutes and is then cathodized at five volts D.C. and 30 amp./sq. ft. for about five minutes.

(b) *Anodizing in a separate bath*

The metal may be anodized in a three per cent phosphoric acid bath at 90 to 100 volts for five minutes,[25] a 40 g./l. (6.5 oz./gal.) sodium carbonate bath at 40 volts A.C. for five minutes,[26] or a chromic/sulphuric electrolyte at 60 volts for 15 to 30 minutes.[27] After washing the metal it may be plated at five volts in either a brass plating or a degreasing bath containing zinc and copper salts. The degreasing bath produces an intense hydrogen evolution; one such bath contains ten per cent sodium carbonate, ten per cent sodium hydroxide, and two per cent potassium cyanide.

The oxide film is partially removed by the above treatments, probably at points corresponding to grain boundaries where the film would be weakest. A thin brass deposit is built into the residual oxide skeleton where it is said to be firmly anchored.[28]

(2) *The Krome-Alume or Travers process*[29] makes

Table 8

Solution Composition	Temperature	Time	Tank	Cost per Gallon
Cleaner	65 - 85°C		Steel	
Caustic Etch 5% Sodium-hydroxide	15 - 45°C	½-3½ mins.	Steel Stainless Steel Rubber lined	8d.
Rinses	15 - 70°C		Wood Steel Lead Lined	
Chromic Dip 26oz/gal.H_2SO_4 5.6oz/gal.CrO_3	65 - 70°C	1 - 2 mins.	Lead lined	
HNO_3/HF Dip 3:1	Cold	5-20 secs.	Hard Rubber Waxed	£1.16.0
HNO_3/HF/H_2O Dip 10:10:80	Cold	5-20 secs.	Hard Rubber Glazed earthen-ware Enamelled Waxed	14.10
HNO_3/H_2O Dip 5:95	Cold	5-10 secs.	Stoneware Acid Proof brick	4.0
Zincate Dip	20 - 30°C	2- 4 mins.	Steel Rubber lined Glass, etc.	7.10

use of a "modifying" solution after anodizing but before plating. This method of pre-treatment is widely used throughout America, and although it is claimed to give consistently good results, it needs careful timing and control.

From various literative sources[15,17,30] it would appear that the method is somewhat as follows: After cleaning in a four per cent sodium cyanide solution, the aluminum is anodized using either A.C. or D.C. in a three per cent solution of oxalic acid at 15° to 20°C. (60° to 68°F.). The temperature must never exceed 30°C. (85°F.). Anodizing is begun at five volts and, keeping the current density below 5 amp./sq. ft., the voltage is raised to 50 volts. This treatment is continued for a total time of ten minutes. After anodizing, the metal is rinsed in cold water and immersed in an 8 to 10 oz./gal. (50 to 65 g./l.) solution of sodium cyanide until small bubbles just begin to appear. This is the most critical part of the method and it requires careful timing. When the bubbles appear (5 seconds for aluminum-copper alloys, 15 minutes for pure aluminum) the work is rinsed and transferred to a nickel or other suitable plating solution. A fairly good bond is obtained, although it is stated[30] that continued mechanical action or pressure on the deposit would ultimately result in its blistering.

During the first few moments of plating the plated metal has a very dark color: this is subsequently plated over with a deposit of normal appearance. *Travers*[30] suggests that with nickel plating, this dark colored deposit is nickel sesqui-oxide (Ni_2O_3) formed as a result of the anodic film becoming highly activated with oxygen during modification. It is thought that this oxygen combines with the first layers of nickel deposited. The final plated metal may, therefore, be anchored to the basis metal through this nickel oxide, and the aluminum oxide formed during anodizing.

Plating on Unmodified Film

1. *Fisher*, in 1936,[31] developed a method consisting of phosphoric acid anodizing followed by plating. This method, which is still in use today, suffers from the disadvantage that different anodizing conditions are needed for different aluminum alloys. The method cannot be applied to casting alloys containing silicon.[19]

After cleaning the metal it is etched either in a solution containing 8 oz./gal. (50 g./l.) of sodium hydroxide at 65 to 70°C. (150 to 160°F.) for three to ten seconds, or in 5 oz./gal. (30 g./l.) sodium carbonate, 5 oz./gal. (30 g./l.) trisodium phosphate. The metal is then rinsed, dipped for ten seconds in concentrated nitric acid, rinsed and anodized at 12 amp./sq. ft. and 15 to 40 volts in 30 per cent by weight phosphoric acid, at about 25°C. (75°F.). The conditions of anodizing are varied with the type of alloy being treated. On finally rinsing, the work is immediately transferred to a neutral plating bath, the pyrophosphate copper solution being especially recommended.[19]

2. A method is sometimes used which consists of an initial chemical oxidation, similar to that used in the M.B.V. process, followed by plating. After degreasing in a ten per cent sodium hydroxide solution and rinsing in two per cent hydrochloric acid, the aluminum is immersed for 15 minutes at 95°C. (205°F.) in a solution containing sodium carbonate and sodium chromate or metavanadate.[32] The aluminum is rinsed and plated directly in a copper sulphate bath.

The pre-plate anodizing processes, as seen from the above descriptions, involve long pre-treatments (10 to 25 minutes), some require to be closely controlled, and some alloys such as the durals always cause trouble. *Krome-Alume Inc.* have recently announced[33] that they have developed a process whereby they anodize at six volts D.C. for only 1½ to 2 minutes, no modification being needed before plating on the oxide film. Such a process would undoubtedly add impetus to the development of plating by anodizing pre-treatments, but as yet no further reference to this process has been found.

The Heavy Metal Dips

A recent paper, published less than a year ago by *Patrie*,[34] indicates that metal dips, which produce pits suitable for keying the deposit to the aluminum) as a pre-treatment for plating on aluminum are still being used quite extensively in France. These dips consist of acid baths containing heavy metal salts: the fact that metal is deposited by these solutions is not important for later plating; rather these solutions produce a satisfactory system of 'keying' pits. These pits result from the formation during pickling of a multitude of electrolytic couples due to the presence of the heavy metal in the solution.

1. *Nickel Dip.*

The method used by *Patrie* prior to chromium plating aluminum alloys is as follows: Articles are degreased, rinsed, and dipped in a solution containing

Nickel chloride ($NiCl_2$)	400 g./l. (64 oz./gal.)
Hydrofluoric acid	2 per cent
Boric acid (H_3BO_3)	4 per cent

at a temperature of 25° to 30°C. (75° to 85°F.) until bubbling due to attack on the alloy diminishes in intensity. The nickel deposit, which is obtained as follows:

$$3\ NiCl_2 + 2\ Al \rightarrow 3\ Ni + 2\ AlCl_3,$$

is more or less uniform, but is not suitable for plating over, and is dissolved off in cold nitric acid (36°Be) before chromium plating. This method is not applicable to duralumin-type alloys. It is claimed that engine cylinders have been chromium plated by this method with satisfactory results.

2. *Manganese Dip*

The same general treatment is used for this method as is used for the nickel dip method. The solution, used at 40°C. (105°F.) for one minute, contains

Hydrochloric acid (22°Be)	500 ml./litre (4 pts./gal.)
Manganese sulphate	4 g./litre (0.65 oz./gal.)

The resulting deposit of manganese is dissolved in a nitric-hydrofluoric acid mixture before plating.

3. *Iron Dip*

Although this dip gives an immersion iron deposit which is used as a basis for subsequent plating, it is included here with the other commonly used heavy metal dips. Good results are claimed,[15] and one such dip, used at 90 to 95°C. (195 to 205°F.) for 10 to 60 seconds, contains

Ferric chloride (45°Be)	0.03 gal./gal. water
Hydrochloric acid	0.01 gal.

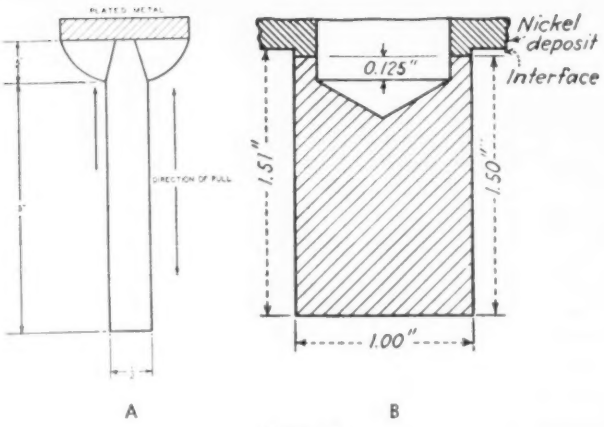


Figure 2

(a) Bullough and Gardam Test. Minimum Thickness of Plated Metal .02 in.

(b) Cross-section of Ollard Test Specimen.

After rinsing the article being treated it is nickel plated: the iron is not removed.[35]

Immersion Deposition

Zinc

This method of pre-treatment consists essentially of depositing a film of zinc on a clean aluminum surface from a bath containing sodium zincate. As this is the most widely applied method of pre-treatment, it is fully dealt with in a separate section.

Tin

Light alloy pistons of Morris eight H.P. cars have been tinned, using an immersion method, to a thickness of 0.0002 inch to reduce friction.[36] One such immersion method employs a solution of 6 oz./gal. (78 g./l.) sodium stannate at 80° to 83°C. (175° to 180°F.) after a cold 20 per cent nitric acid dip.[37] Laboratory tests carried out by *Heiman*[23] showed that while sound tin deposits could be obtained, the conditions of deposition were critical and the adhesion of these deposits was not as good as the adhesion of deposits produced by the zincate method. The conditions which he found most satisfactory were a five to ten seconds dip at 25°C. (77°F.) with fairly vigorous agitation in:

Stannous sulphate	160 g./l.	26 oz./gal.
Hydrofluoric acid (48% acid)	70 ml./l.	0.56 pints/gal.
Hydrolysed glue	1.0 g./l.	0.15 oz./gal.
Goulac	0.2 g./l.	0.03 oz./gal.
Purified residue glue	1.3 ml./l.	0.01 pints/gal.

A recent patent[38] describes a combination of immersion and heat-treatment. The aluminum is wetted in a 10 g./litre (0.15 oz./gal.) solution of stannous chloride, and then heated for five minutes at 500° to 600°C. (930° to 1110°F.) to reduce the salt to metallic tin which alloys with the aluminum.

Copper

Copper has been deposited by immersion in a molten cuprous chloride bath at 430°C. (1075°F.) .[19,23] It is claimed that adhesion between the copper and aluminum is good but the method has the disadvantage of fully annealing heat-treated or cold worked alloys.

Cadmium

Heiman[23] has recently developed a method for depositing cadmium. He recommends a 5 to 10 seconds dip with fairly vigorous agitation in the following solution at 25°C. (77°F.):

Cadmium sulphate	3.6 g./l.	0.58 oz./gal.
Hydrouoric acid (48% acid)	105 g./l.	0.84 pints/gal.
Hydrolised glue	2.0 g./l.	0.32 oz./gal.

When plating the deposit he found a cyanide copper strike desirable.

Direct Plating

The term 'direct plating' of aluminum alloys is used very loosely in the technical literature. It has been used to mean plating on a zincate or other film, plating on an unetched or very lightly etched surface and plating on a heavily etched surface. The term is very misleading but confusion could be avoided by reserving its use for the last two meanings listed above. The manganese and nickel dips could have been included in this section but are discussed under their more usual heading of "heavy metal dips."

It is claimed [39,40] that deposits of chromium can be applied directly to aluminum alloys by first using a light acid etch such as a dip in five per cent hydrochloric acid, then plating in a standard chromium plating solution at twice the normal current density.

Zinc is deposited on a smooth aluminum surface from a solution containing three per cent each of zinc cyanide, sodium cyanide and ammonia solution (Sp. Gr. 0.88), to which is added 0.1 per cent peptone.[41] The current density may be in the range 1 to 5 amp./square foot and the time between one and ten minutes.

A solution said to strip the oxide film and deposit zinc simultaneously, contains 2 oz./gal. (12.5 g./l.) each of sodium cyanide and zinc carbonate, and 1 oz./gal. (6.3 g./l) sodium hydroxide. The aluminum is plated at 65° to 70°C. (150° to 160°F.), 10 to 12 amp./square foot for 30 to 60 seconds.[15]

A recent French process[42] describes a method whereby the aluminum is etched in 20 per cent hydrochloric acid for a few seconds and then plated at four volts in the following solution at 15°C. (60°F.).

Nickel sulphate	100 g./l.	16.0 oz./gal.
Sodium sulphate	50 g./l.	8.0 oz./gal.
Ammonium chloride	35 g./l.	5.6 oz./gal.
Sodium hydroxide	3 g./l.	0.48 oz./gal.
Citric acid	3 g./l.	0.48 oz./gal.

Testing Adhesion of Deposits

Of the several methods proposed for the testing of adhesion of electrodeposits on aluminum only the tensile testing method developed by *Bullough* and *Gardam*[21] and that of *Ollard* gives quantitative results (see Fig. 2). Tests presenting qualitative results only, but which, nevertheless, are of value, com-

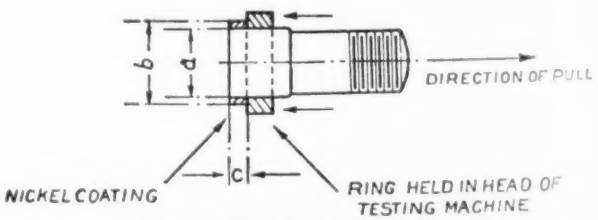


Figure 3. Shear-Type Adhesion Test.

Table 9

Metal Plated	Type of Service	Thickness (ins)	
		Min.	Max.
Nickel	a. Arduous. Open weather, marine, tropical.	0.0010	0.0020
	b. General purposes. Indoor in temperate climate	0.0005	0.0010
	c. Light duty	0.00025	0.0005
Chromium	Decorative	0.00002	0.0005

prise bending and twisting to cause fracture, peening with a hammer, and various heat treatments.

At D.R.L., it is proposed to employ shear-type adhesion tests as described by *Wilson*[43] (See Fig. 3).

Current Research

Much research has been, and is being carried out on the subject of plating on aluminum, but almost all of the recently published reports concern the immersion processes, with particular attention to the zincate pre-treatment. The following is an outline of some of the recent work which has not so far been reviewed in this paper.

Corrosion

The *Mond Nickel Company* have investigated[2,44] the nickel plating of aluminum, using the phosphoric anodizing, and the zincate immersion pre-treatment methods. Heavier coatings were found to be needed when the latter method was employed, nevertheless it is pointed out that this method can be used on a greater number of alloys than the former. The substitution of a portion of the nickel plate by an equivalent thickness of copper, resulted in inferior corrosion resistance. Table 9[15,45] shows suggested nickel plate thicknesses.

Plated Metal Thickness

Adhesion Testing

The only published results of adhesion tests on plated aluminum have been those of a tensile nature. A systematic investigation of the adhesion of deposits after various pre-treatments have been employed has not yet been attempted.

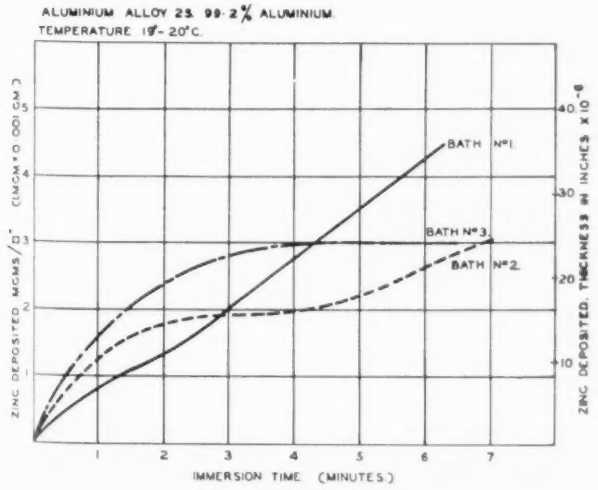


Figure 4.

Zincate Method of Pre-treatment

(a) *Thickness of Zinc Deposited*

As seen from the graphs in Fig. 4 (from the author's results), the amount of zinc deposited from the zincate solutions does not vary directly with time of immersion, but varies in an irregular manner.

Although it has not yet been confirmed, it is expected that deposits with the best adhesion will be obtained when conditions corresponding to the central, flat portion of the curves are used. Conditions of immersion, represented by the steeply rising initial part of the curve are thought to produce zinc deposits which do not complete cover the surface of the aluminum; conditions represented by the final gently sloping section probably produce an inferior deposit tending to become 'spongy.'

Bengston,[17] and *Bullough* and *Gardam*,[21] have made similar investigations on the thickness of zinc film deposited, but their results are widely different (the latter obtained a thickness three times that of the former). The author's results are different from either

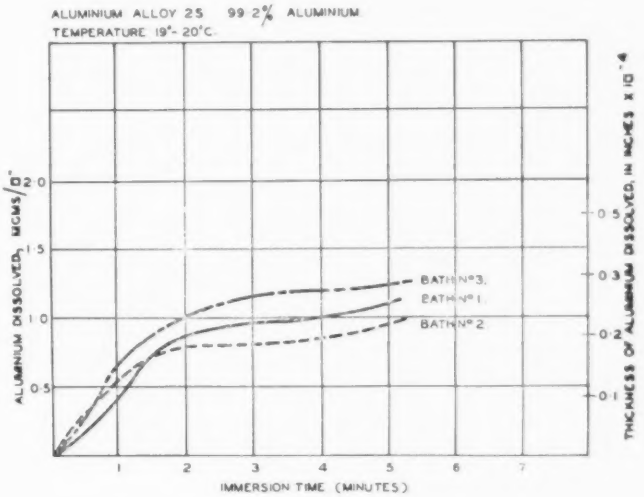


Figure 5.

the work of *Bengston* or *Bullough* and *Gardam*. The reason for these discrepancies is not known.

(b) *Thickness of Aluminum Dissolved*

The amount of aluminum dissolved from commercial aluminum, in the zincate dips, also varies with time of immersion, as is shown by the graphs in Fig. 5.

(c) *Explanation of Adhesion Obtained between the Zinc and Aluminum*

Bullough and *Gardam* have suggested the following theory[21] in an attempt to explain the good adhesion obtained. Aluminum crystallizes in a face-centered cubic lattice system of 4.04 A°, and zinc in a close-packed hexagonal system with lattice constants of 2.66 A°. The solution of two aluminum atoms results in the deposition of three atoms of zinc, and it is significant that $^2/_3$ of 4.04 = 2.69.

$$3\ Na_2ZnO_2 + 2Al + 2\ H_2O \rightarrow 2\ NaAlO_2 + 3\ Zn + 4\ NaOH.$$

Thus, a row of aluminum atoms 4.04 A° apart can be replaced by 1½ times as many zinc atoms 2.66 A° apart. This would occur in the 110 plane with very

little lattice distortion, and it could result in excellent "atomic" adhesion.

Conclusion

This paper has attempted to cover the more important aspects of plating on aluminum, and in particular to discuss the history of the subject, describe the commonly used methods for the benefit of the practical plater, give some idea of the theory of processes used, and outline some of the difficulties encountered.

In conclusion, it may be stated that although plated aluminum has its disadvantages, it is here to stay, and during the next ten years, we should see easier methods of plating being developed, and the number of applications greatly increasing.

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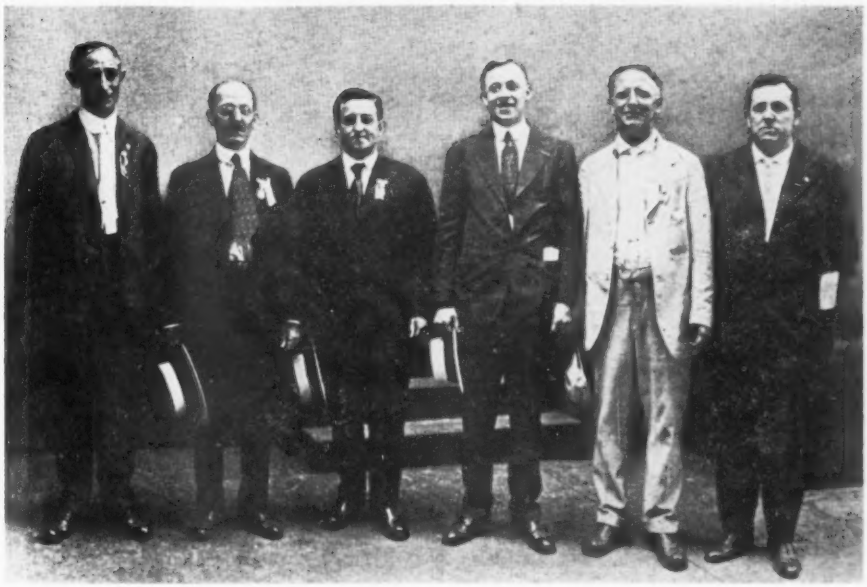


National A. E. S. Officers for 1917-1918. L. to R.—Walter S. Fraine, Pres.; G. B. Hogaboom, 1st V. P.; W. J. Salmon, 2nd V. P.; O. E. Servis, Sec'y-Treas.; H. J. Richards, Editor of A. E. S. Bulletin; H. H. Williams, Past Pres.

All Our Yesterdays—Part XV

By Frederick A. Lowenheim

THE years 1917 and 1918 were fateful ones in our history, for they marked the first occasion when the United States became involved in a World War. Events moved rapidly during the first months of '17, and we can only skim over them briefly. Of items of general interest we may note that "Buffalo Bill" Cody died on January 10, and six days later Admiral Dewey, of Manila fame, followed. The Virgin Islands officially became a U. S. possession on the 17th. In February the U. S. recognized the Carranza Government of Mexico and withdrew the troops which had been stationed there. Six weeks later we recognized the new, short-lived regime in Russia. Tom Mooney was convicted of murder in connection with the San Francisco bombing, and sentenced to be hanged.

The important news, of course, had to do with the worsening relations with Germany: the activities of her consular officials in attempting to sabotage arms shipments to the Entente powers, the fires and explosions of incendiary origin in munition plants, and Ambassador von Bernstoff's request to his government for a $50,000 appropriation to "influence" Congress. In the last day of January Germany announced the resumption of unrestricted submarine warfare, and four days later we severed diplomatic relations. As more and more American ships were sunk and the situation deteriorated hopelessly, we declared war on Germany on April 6. On succeeding days our diplomatic relations with the other Central powers were broken.

Although our involvement in the first World War was not nearly so deep as in the second, the effects on the industrial life of the country were in many ways comparable. For our present purposes we are concerned with the electroplating industry, and it is probably not far from the mark to date "modern electroplating" from the effects of World War I. From being largely concerned with decorative effects and — to put it bluntly — palming off inferior goods on an unsuspecting public, the electroplater found himself an integral part of the war effort, engaged in producing or helping to produce ammunition and materiel essential to his country's success in the field. The change wasn't instantaneous, as we shall see, but the "old days" were numbered.

Even before our entrance into the war, shortages and high prices began to plague the industry, and the trade journals were liberal with suggestions on means of conservation and substitution. Copper solutions without cyanide, substitutes for tin, and similar topics were given prominence. One correspondent proposed a somewhat drastic solution, in an article called "Solving the Cyanide Shortage":

"The question of supplies, particularly cyanide, for the plating room is steadily becoming most serious. The prices of cyanides and other essential supplies are advancing at a rate that is without precedent; they have already reached an elevation that is well-nigh prohibitive and are still soaring towards a point which seems to be located on the other side of infinity. To the manufacturers who must meet the prices, the situation has become a nightmare of daylight robbery, if I may be permitted such a mixed figure of speech. To the plater it is a wearying round of trying to get along without this and that chemical, and a promise of a shut-down in the near future from the inability to get those necessities at any price.

Of course the war is blamed for it all. But most of these products are made in this country, and the raw materials are still available at prices which, while they are considerably above normal, are nevertheless not at all in proportion to the prices asked for the finished products. The explanation is more properly to be sought in the surmise that a single company has control of their manufacture and is holding out for unfairly large profits.

At present writing (December 12, 1916) cyanide is tem-

porarily priced at $1.45, taken on the run as it soars past. Ammonium sulphocyanate, essential to the black nickel process, is difficult to get at a price of $2.50 per pound for small lots.

There are a number of ways in which savings in cyanides over the usual methods may be effected; and furthermore, there are simple emergency processes by which a fair grade of cyanide, suitable at least for cleaning purposes, and in fact approaching the quality of certain cyanides now on the market may be prepared. . . .

The source of most of the cyanide manufactured is sodium ferrocyanide ($Na_4Fe(CN)_6 12\ H_2O$), also known as yellow prussiate of soda . . . The method most used is to fuse the prussiate with metallic sodium, the products being sodium cyanide and metallic iron, which settles out. An older method is to fuse the prussiate with soda ash. Here, however, sodium cyanate NaCNO is formed along with the cyanide as follows:

$$Na_4Fe(CN)_6 + Na_2CO_3 = 5\ NaCN + NaCNO + Fe + CO_2$$

At present, yellow prussiate of soda is selling at from ¼ to ⅓ the price of sodium cyanide, and it is reported that there is a reasonable supply available on the market. It contains about 30% cyanogen, as against 53% cyanogen in perfectly pure sodium cyanide, so that when the price of prussiate is about ⅓ that of cyanide, or less, the cyanogen in the form of prussiate is cheaper than in the form of cyanide. If the factory has the facilities for fusing about fifty to one hundred pounds of material at a time in a good sized iron kettle, it would pay the plater to have his sodium cyanide manufactured in the factory. . . ."

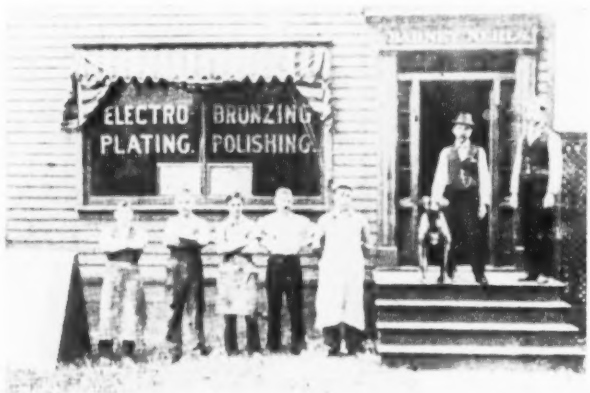
After listing other possible methods of preparing one's own cyanide, the author turns to means of conserving those supplies the plater has managed to acquire:

". . . Hot cyanide solutions are much more costly to maintain than cold ones. Under normal conditions, the increased cost of maintenance is outbalanced by the increased rate of deposition which is made possible, resulting in an enlarged capacity and a consequent reduction in overhead charges. But at the present time in most cases it is rather doubtful if the increased cost of maintenance is worth while."

The article concludes with a discussion of non-cyanide solutions. The principal manufacturer of cyanides was quick to deny the implications that he was profiteering, for in the very next issue of the journal appeared this exchange of letters:

"Under the present serious conditions of cyanide shortage caused by the reduction of power at Niagara Falls, where one of the elements of the cyanide manufacture is produced, articles of this nature are welcome and desirable, our efforts being bent in the same direction.

However, the writer of the article seems to be seriously misinformed as to the situation; we mean the position taken by us as manufacturers of cyanide, so far as the price is concerned. If he will take the trouble to look into this question, he will find that today's prices of cyanide, with the exception of small advances, due to the increased cost of raw materials, have remained practically unchanged, and that this company is not taking the smallest advantage of the exceptional condition of the market. Over 90 per cent. of its production of cyanide is delivered and charged direct to consumers, the remainder going to dealers, who, we have every confidence, follow this company's line of policy. There may be a few exceptions; only to these exceptions can the remarks of this article . . . refer. . . ."



The first job plating shop in Detroit, the Bromley Electroplating Works, established in 1875 at 101 Miami Ave., (now Broadway).

The original author retorted:

"I wish to remind the writer of this letter that in my article I attacked not a firm, but a general condition of the market. If the writer of the letter wishes to assume for his firm the responsibility for this condition of the market, as his letter indicates, that of course is his undisputed privilege.

That such a condition of the market as I described existed is too well known among the plating profession to require elaborate proof. My statements as to the prices were based on market reports . . . [and] further on the experiences of electro-platers of my acquaintance, who have not been users of metal cyanides, and who have been forced to pay as high as $2 a pound for cyanide.

I wish to quote the following statements as to exportation of cyanide from New York. These figures are for one week:

	Pounds
To Mexico	39,400
To Honduras	33,600
To Philippine Islands	10,665

The total for this week is 83,665 pounds, or at the rate of over 350,000 pounds per month.

I am glad to have the assurance of the —— Company that they, at least, are endeavoring to conserve the nation's supply of cyanide for American manufacturers as it is certain from the export figures just quoted above that somebody in the United States, who has control of extremely large quantities of cyanide, is not acting so loyally towards the American consumers of cyanide."

Prices of many other commodities got out of hand during this period, and the shortages and other inconveniences with which the plater of 1917-18 had to contend will be all too familiar to the plater of today. Extended quotation from the literature of the period hardly seems necessary, but the general situation was summed up in a Review of the Plating Industry for 1917:

"In reviewing the plating industry of the year 1917, the entry of the United States into the world war has had many important bearings upon the industry and has increased the demand for plated products to very large proportions. If we were all familiar with the thousand and one articles from metal that are used by the Army and Navy departments, from the tremendous coast defense guns to the common pin, we could then realize the large increase in metal products that are required for our expeditionary forces to accomplish the work that has been laid to make the world free for Democracy.

The specifications covering the plating of steel parts for aeroplanes are a surprise to the writer, and I feel sure that practically no protection from corrosion due to atmospheric conditions can result from the deposition of copper and nickel, totaling .0008 of an inch as the minimum and not exceeding .001 of an inch, as the maximum. Copper and nickel do not give a rust free coating unless the deposits are unusually heavy and free from a porous deposit, which is usually due to the occlusion of hydrogen. In my opinion, zinc should be used exclusively for steel products for non-corrosive protection against weather conditions, and such a deposit should be obtained from the alkaline zinc solution, as this type produces an adherent coating, uniform in texture and non-crystalline. Such a deposit should not be below .001 of an inch, and after plating in the zinc solution the articles should be washed thoroughly in cold and boiling water and then immersed in a solution of equal parts of paraffin oil and paraffin heated to a temperature of 212°F.

We have recently heard comments and criticism of men employed in the various departments of the Government due to the inefficiency and lack of practical knowledge of the various manufactured products that come under their super-

vision. I am going to try and make a plea for more efficient co-operation from this standpoint, thus eliminating politics and theory. I do not know of any well-known practical man who is in the employ of the Government for the supervision of plated products, but there are such men if the Government will only ask for them.

Taking the plating industry as a whole then, it may be said that it has made important progress during the past year, both chemically and mechanically. For instance, a number of patents have been issued that have enabled the plater to produce a greater output; the metal cyanides have practically eliminated the use of carbonates in plating solutions, etc. The economy in the use of the metal cyanides has been in the saving of cyanide, which has proven to be an important factor owing to the cyanide conditions during the past year, and the same conditions will practically exist during the year 1918, owing to the uncertainty of raw materials. However, it seems that the price of 37 cents per pound for sodium cyanide (96-98%) will be maintained.

Labor conditions, however, are in serious straits and it is apparent that the women will have to take up the work of the men in order to keep up production."

In at least one respect, however, the two wars differed, in that conventions and meetings during the first continued as usual. In 1917 the Electroplaters met in St. Louis — in July. (Was the weather different in those days?) Those of you who take for granted a liberal expense account for attending conventions may be interested in the reactions of one member, as published in the correspondence columns:

"The representation of the Eastern members was beyond all expectations, owing to the great expense for the long journey. Many of the members, in the past, have had to meet this expense personally. The firms employing these men should co-operate with them in every way possible, it being directly to their advantage to do so. To cite one of many cases, one of the members who attended the convention in Cleveland last year on his return to work told his employer about the proceedings, the papers that were read, his trip through the various manufacturing institutions. Incidentally he mentioned the improvement he was able to make in his methods of handling his equipment. When the member finished his discussion of the convention and what he had observed, his employer asked him how much it cost. (He) got a statement from him that indicated what his fare and expenses were, and the member was greatly surprised to find a check in his mail next day covering it.

If it were only possible to publish the papers that were read and the discussion that followed, it would require no urging of employers to see that they were represented."

The next year, 1918, the platers met in Detroit. A report of the meeting indicates that the old question of the electroplater's knowledge of chemistry was still being debated, and you will note, also, the entrance of some contemporary actors upon the stage of our history:

"A paper was presented on 'Metal Cyanides and Sodium Carbonate in Brass Plating.' The equations by which Mr. —— attempted to express his reactions were so faulty, however, as to call forth a very earnest plea from Dr. Blum for the electroplaters to first study the elements of chemistry before attempting to express reactions in symbols.

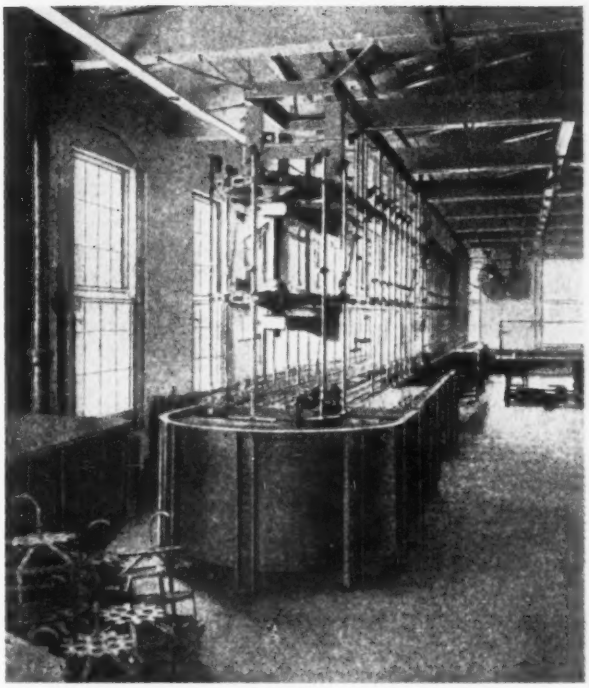
The discussion drifted to good connections, whereupon Brother —— wanted to know what was the difference whether current was lost in connections or in the rheostat, as long as the required current was delivered at the tub.

This sure was a sticker. You had them there, son!

. . . Mr. Mesle gave quite a lengthy plea for standardized methods of measuring. Some platers measure current in volts, some in amperes. They do not know the temperature under which a test was made or the relation between anode and cathode surface.

Dr. Blum spoke generally on the change which came over the plating industry since it had been recognized as one of the vital industries in the World War."

The New York Branch held its annual banquet,



The Broderick full-automatic plating machine, eighteen of which were in operation in Conn. plants in 1917.

featured by a menu which we quote here on the theory that even pure corn is better than no humor at all:

MEAN YOU

Indigo Points 50-50 (half on and half off)
Tarnished Olive Salary
Cream of Chicken with H_2O (very weak)
Young and Tender Croquets with Guardians
Cyanide Bath
Ex-capon a la Scratch Brush, Stuffed with White Lead
Spuds with Saccharine
Milk Below Zero
Tripoli Cakes with Silver Plated Frosting
Black Nickel (very little)
Choice of Stogies and Corn Cobs

Following the dinner, *Dr. Blum*, of the United States Bureau of Standards, gave a resumé of the work the Bureau has been doing in reference to electro-plating in general, with particular emphasis as to the treatment of parts of aeroplanes in order to render them resistant to the corrosive effects of the atmosphere. At the conclusion of Dr. Blum's speech he earnestly urged the co-operation of the Electro-Platers' Society with the Bureau of Standards for the furtherance of the establishment of methods for weather proofing metallic materials.

At the suggestion of *George B. Hogaboom*, a resolution was passed in the form of a rising vote that the members of the New York branch at least pledge themselves to do all in their power to aid the Government in its work of winning the war.

This report may have marked the first time — though it certainly wasn't the last — that the names of Blum and Hogaboom were so closely coupled.

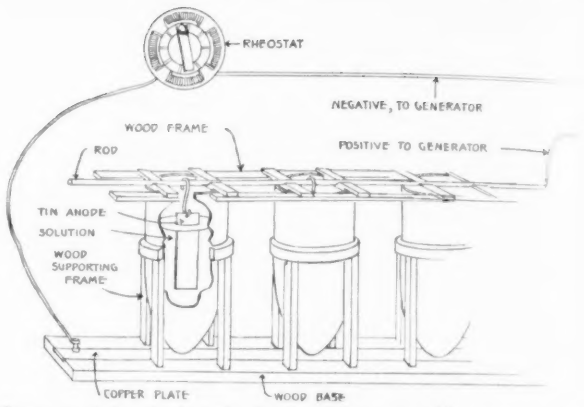
On May 10, 1917, John J. Pershing was named head of the American Expeditionary Forces; he sailed on the 28th and arrived in Paris June 13, the same day that the first American troops embarked. On June 5 almost eleven million men registered for the draft; the first drawing was held on July 20, under a system very similar to the one in force during the recent war. Demands for federal price control began to be voiced;

later in the year the Department of Agriculture reported that prices were 31% above 1916 and 100% higher than the average level during 1911-1915. Wheat hit $3.25 on the commodity exchange and trading in it was forbidden. As always during periods of sharply rising prices, strikes were numerous, among the more serious was an almost complete tie-up of the copper mining industry. There were riots, too, including an ugly race conflict in East St. Louis in which more than 100 were killed; there and in Houston martial law was invoked to cope with the situation. Some of the labor trouble had a political background, fomented by the "Wobblies" — International Workers of the World, or IWW; in September its headquarters in 23 cities were raided and among those arrested was Big Bill Haywood, its president. There were other nonconformists, too, and in the intolerant atmosphere prevailing during wartime they found themselves often in conflict with the Government; the two famous anarchists, Emma Goldman and Alexander Berkman, were arrested for interference with the draft, sentenced to two years in prison and $10,000 fines — a verdict upheld by the Supreme Court in the near-record time of six months. A Socialist Party congress condemned the entrance into the war by an overwhelming vote which led to a split in the party; and a name which was to be anathema to radicals made an innocent-appearing entrance on the national scene: Mr. A. Mitchell Palmer is appointed Custodian of Enemy Property.

On October 21 American troops entered the lines and saw their first action on the 23rd. In November the famous "Rainbow Division," representing every state in the Union, landed in France. As conservation measures, a series of go-without days was inaugurated, with lightless nights, to be followed by heatless days, meatless days, gasless Sundays, and others. In the Lansing-Ishii agreement the United States officially recognized Japan's "special interests" in China and reaffirmed the policy of the open door. China protested — with the usual result. On December 7 we finally declared war on Austria-Hungary. On the 26th the railroads were placed under government control and operation, thus setting off an argument that hasn't been settled yet; and on the 18th both houses of Congress passed, and sent to the states for ratification, an amendment to the Constitution providing that "the manufacture, sale, or transportation of intoxicating liquors within, the importation thereof into, or the exportation thereof from the United States and all territories subject to the jurisdiction thereof for beverage purposes is hereby prohibited." And that started quite an argument, too!

Independently of the war, which merely hastened the process, electroplating was coming of age; although, as we shall see, many erroneous and even ridiculous ideas about the chemistry involved were still current.[1] There were many more articles than formerly concerned with the engineering aspects of plating — one of the signs of maturity. In particular, an article entitled "The Mechanical Engineer in the Electro-Plating Industry" is worthy of mention. The main point of the article is an argument relatively new at the time: the coming era in plating will be the age of the engineer.

[1]*This could be interpreted as a pun. Sorry.*



Setup used for tinning the inside of brass cartridge cases during World War I.

The basic inventions have been made, the plating solutions have been more or less perfected, and it is time for the mechanical engineer to step in and improve efficiency, develop machinery such as barrels, automatics, and the like with the aim of putting electroplating on a sound technological basis. And, always allowing for the inevitable one-sidedness of such a presentation, it strike us that this writer of 1917 came very near hitting the mark.

Another sign of the times was the increasing concern over standards and standardization; once again this was heightened, but by no means created, by the war. We quote one of the many discourses on the subject:

"The writer recently received the following letter from a well-known manufacturer of plumbers goods.

'We have had a difference of opinion with one of our customers as to what constitutes heavy nickel plating, and in order to answer the question authoritatively, will you kindly advise us what would be good commercial practice in this particular case. We find that the platers always gauge their work by the length of time that the article is in the tank, but that none of them have any idea as to exactly how thick the deposit is and it is this point we would like to get at. In other words, if it is good commercial practice to give the article an hour in the tank, what would be the exact thickness of the deposit?'

The above letter speaks volume for the rule of thumb methods still in vogue in the majority of plating plants in the United States. Is the time not ripe for commercial standards? There is no commercial standard for electro-deposits and the United States Government has no standard of weights of deposits in their specifications, for they depend upon the nitric acid tests, excepting in zinc plating, and then the usual sulphate of copper test is applied to determine the wearing of the thickness of the deposit.

The U. S. Government specification for silver plate is a triple plate. The thickness of a single plate has never been determined, so a double, triple and quadruple plate is equally as vague.

It seems to the writer that the Bureau of Standards of the United States Government should be the medium through which commercial standards can best be developed and that it should not be neglected any longer."

Should we do our own plating or send it out to job shops? This question must have been debated in factory offices innumerable times, down to the present day; one manufacturer wrote a letter to the editor about it and received an answer which retains a degree of interest.

"We are manufacturing, and most of our instruments are nickel-plated. Our plating bills amount to $300 per month with jobbing platers. We woud like to know if you have any figures as to whether it would pay to run a plating plant on such a small amount of work. We would also like to know the approximate investment required."

The Editor did the logical thing: he sent the inquiry

along to a few platers' supply firms, and got two answers, both of which he printed. The first:

"There is a question whether it is practical to install a plating plant when the amount of work amounts to $300 per month. One might be able to have plating done a little cheaper on the outside, but if one will do his own work, the chances are he will do a better job, and it is more convenient. I have talked with a number of concerns who have installed their own plating plant, and ninety-nine times out of a hundred they are satisfied with their purchase and would not go back to the old method of sending work to a job plating shop.

I add an estimate which covers a plant for doing nickel-plating on a small scale, and it would be large enough to do considerably more than $300 worth of work of all kinds.

ESTIMATE

1—150-ampere, 6-volt shunt-wound, self excited generator, field rheostat slide rails and pulley	$147.50
1—volt-meter, 6 terminal	18.50
	$166.00

NICKEL SOLUTION

1—wooden tank, 48x24x24 ins., 2-in stock	$ 16.25
8—8x16 nickel anodes, approx. 130 lbs., 52⅓c	68.25
125 lbs.—double nickel salts, 12c lb.	15.00
25 lbs.—single nickel salts, 16c lb.	4.00
3 pieces—brass tubing 52 ins. long each, 1-inch diameter, with connections for same	7.50
1—rheostat	12.00
12 feet—⅜ in. bus-bars	3.00
1 gallon—prepared tank lining	1.75
1—welded steel potash tank, 30x24x24 ins.	36.00
1—welded steel hot water tank, same	36.00
1—cold running water tank, same	15.00
	$214.75

In connection with the above it will be necessary to have a few crocks, jars, brushes, pumice stone, whiting, potash and other items, which will not run over $10.00 to $15.00.

Also, if one intends to do polishing and buffing, it will be necessary to have a polishing lathe, which will run from $30.00 to $50.00, and a quantity of buffing wheels, polishing wheels, glue pot, which will probably run up to $50.00, for doing work on a small scale. . . .

The second answer was to the same effect, though less informative in detail:

"We would state that, in general, manufacturers of merchandise who are sending goods to jobbing shops having bills amounting to approximately $300 per month would be warranted in installing an electroplating plant in their own works, and should make a saving equal to that of the profit of the job on the amount of work turned in by them to the job shop."

One misses, in the modern technical and scientific press, that easy communication between the editor and his readers which we have seen to be one of the outstanding features of the journals of thirty-five years ago. Regular columns were set aside for correspondence and discussion, and it was seldom indeed that these columns were not well filled — and in small print, too. Today, if you disagree with an article in this or another journal, you are likely merely to swear softly to yourself: your predecessor swore out loud to the editor.*

We have quoted many examples in previous instalments of this series; here's another:

"In a civil manner I would like to ask if you have on your staff of manuscript readers any technically trained men, men who have a good general knowledge of chemistry and electricity, etc.? If I should write you an article on 'Black Is White,' 'Nickel Sulphate is Pink,' or on some other topic the untruth of which is equally as self-evident, would you print such an article on the strength of the supposition that I knew what I was talking about, or would your technically trained staff return my manuscript as being unfit for publication?

My reason for asking these questions is this. Several times I have noticed articles in trade journals on 'The Function of Boric Acid in Nickel Solutions,' and 'Depositing Brass, Copper and Zinc Upon Die Castings, Aluminum and Zinc from Cyanide Solution,' which are not only absolutely chemically erroneous, but ridiculous in the extreme.

It is hard to believe that anyone can know so little about chemistry as the writer of these articles leads one to infer. It is not right that a trade journal having so many readers should accept and print such untruths, for there are always some men who are impressed by flowery language no matter how little truth the statements contain.—CHEMICO."

That this writer's complaint was in some instances quite justified has appeared before in this series, and will reappear further on. While we are at it we might quote a few more letters. This one is about the cleaner business:

". . . One of the most important operations of the plating business is to have the work absolutely clean; it must be free from oils, grease and stains to receive an adherent deposit, as cleaning is fully 50 per cent of the plater's troubles . . . The writer has done considerable experimenting with the various cleaning agents and investigated their merits, and I have still to see the high priced cleaner do as good work as one I have used for four years . . . just why any plater or manufacturer should pay high prices for their cleaning agents is beyond me. If the plater understood chemistry, he would understand his cleaning problem. The trouble is that few of the platers understand chemistry and naturally the manufacturer looks to his platers for suggestions. The result is that the plater or purchasing agent falls a victim to a smooth tongued salesman . . .

The writer knows of a case where a certain cleaner was put in on trial, and after a period of several weeks trial the salesman was informed that his cleaner was no good. Upon investigation it was found that the plater was prejudiced and did not even open the barrel since it had been received by him. The fact does not dawn upon the average plater that he can make a most excellent cleaner for a few cents a pound instead of paying fancy royalties to salesmen and commission men.

A point generally impressed upon the plater by the manufacturer of certain cleaning agents is that the plater can wash his hands in the cleaner without hurting them. Why should a plater want to wash his hands in a cleaner in the first place?"

The remedy is to learn chemistry. Then, and not until then, will there be efficiency in the plating business and the mysterious addition agents disappear from our markets."

"During the past fifteen years," remarked the editor about the following query, "we have replied to 2,566 firms and individuals who wished technical information, and we have answered some five thousand people who wished commercial information. To the best of our knowledge and belief these questions were answered satisfactorily to the questioners, but we must admit that at last we are stumped when the following question is put before us."

SWEDEN, Lulia den 14, Dec., 1917

To the Editor:

As I daily do read your language I hereby kindly ask if I through your office can buy or get address for:

1—really good shaving knife to 25 or 30 shilling.

1—really good hair cutting machine to above price.

1—lady photo about 20 year to get married with.

I reply to get an answer from you and remain to hear your subscription duty for 1918.

H—— J——"

We never did discover how H— J— made out. Possibly after a shave and a haircut he was able to get a woman without outside help.

A search of the question-and-answer columns elicits a few items to include here. One questioner was bothered by the pitting of nickel deposits; he was told that

(Editors haven't changed, but readers have. Who ever sits down and writes the editor these days? Suggestions and criticisms are welcome by the editors, but they're as rare as a double-breasted coat on a Phi Beta Kappa man.—Ed.)

pits were caused by hydrogen bubbles, and the thing to do was to agitate the work rod, or to hit the work rods a smart tap with a wooden mallet every 15 or 20 minutes.

There were many requests for a satisfactory substitute for cyanide, reflecting the situation caused by the war. The answers were short and to the point: there isn't any.

The state of the art, as they say in patent cases, in tin plating is reflected by this inquiry for a "good standard thickness for electroplated tin." The answer: "The deposit obtained is never more than a flash plate and we are unable to advise what would be considered a proper weight. All heavy tin deposits are applied by hot dipping."

One questioner drew two blanks at once: he asked for the best method of plating aluminum with nickel, and a solution for a tin bath to refinish old milk cans. A.: "Aluminum cannot be electroplated with any degree of success. There are several formulas for tin baths but as the deposits obtained are thin and more or less granular there are no tin baths suitable for the work you mention."

Other matters on which little progress had been made are the subjects of these questions: a correspondent wanted to know what firms sold plating racks insulated so that nickel wouldn't adhere to them; he was told that plating racks weren't sold, they were made in and by the shops that used them. And, Q.: "Is there any literature on the electrolysis of aqueous solutions of chromium salts? Is there a formula for such baths which is hopeful?" A.: "We do not know of any literature treating of electroplating with chromium and have been unable to find anyone who has attempted to electroplate with chromium to any extent."

On January 8, 1918, Mississippi gained the dubious honor of being the first state to ratify the proposed eighteenth amendment. Other states were not far behind: Virginia, Kentucky, South Carolina and North Dakota all said yes in January, Maryland and Montana in February, Texas, South Dakota and Delaware in March — and so it went through the year. It wasn't unanimous: Rhode Island and New York dissented, but their voices were almost unheard. Death claimed the pugilist John L. Sullivan on Feb. 2. On the 16th New Jersey passed a so-called anti-loafing law, which provided that all able-bodied males must be regularly employed in some useful occupation, and in May New York enacted a similar law. Official harassment of non-conformists and suspected German sympathizers continued: Karl Muck, conductor of the Boston Symphony Orchestra, was arrested as an enemy alien; orchestras stopped playing Wagner's music, German measles became liberty measles and sauerkraut was liberty cabbage. All over the country Germania Halls and Germania Squares and Germania Streets were hastily renamed, and little boys who (like myself) were nicknamed Fritz had to learn to fight or to run.[2] The editors of the MASSES (Max Eastman, Floyd Dell and Art Young) were on trial for sedition, but no convictions were returned. One enduring result was Art Young's famous cartoon, "The Artist on Trial for His Life." President Wilson applied to the Governor of California for executive clemency for Tom Mooney, and two towns in California were wiped out by an earthquake. A new-fangled scheme called Dalight Saving Time was tried out. On May 15 airmail service was inaugurated on the Washington-New York run, and later extended to New York-Boston-Montreal. On June 26 rationing of sugar began: 3 pounds per month per person was the allowance, later reduced to two. On June 28 the Chemical Warfare Service was created, and on June 30 another famous dissenter ran afoul of the law, as Eugene V. Debs was arrested for "interferance with recruiting."

[2]*The reader will be left in suspense as to which I did.*

Meanwhile the platers were reading articles on Tinning the Inside of Brass Shells; on Cobalt plating, Antimony plating, and Lead plating; on Government standards and the work of the Bureau of Standards in the electroplating field; on military applications of electroplating; and of course on the standard topics of copper, nickel, brass, and zinc deposition.

Of more appeal to our essentially frivolous nature are some additional examples of weird electrochemistry culled from the press of the time. It is not meant to imply that all, or even a considerable number, of platers were as muddled as the examples we shall quote might suggest; it should be remembered, too, that the theory of ionization was still rather recent. On the other hand, the fact that these articles brought forth comparatively little protest from the usually disputatious readers seems remarkable.

Here is an author asking the question, "Single or Double Nickel Plating Salts, Which?"

"Notwithstanding the many advantages that nickel sulphate ($NiSo_4$, 7 H_2O) has over nickel ammonium sulphate [$NiSO_4$ $(NH_4)_2SO_4$ $6H_2O$] many platers persist in the use of the double salt solution . . . Nevertheless, the evil that there is in double salts remains and exerts its influence."

After comparing the two salts for solubility, metal content, etc., he continues:

". . . When $(NH_4)_2Ni(SO_4)_2$ 6 H_2O is used for plating, concentrated solutions of it are used. By application of the dissociation theory, one would be justified in assuming the existence of very little nickel in ionic state.

$(NH_4)_2Ni(SO_4)_2$	$NH_4 + (NH_4Ni(SO_4)_2)$	(1)
$NH_4Ni(SO_4)_2$	$NH_4 + Ni(SO_4)_2^=$	(2)
$Ni(SO_4)_2^=$	$NiSO_4 + SO_4^=$	(3)
$NiSO_4 +$	$Ni + SO_4^=$	(4)

That (1) and (2) would predominate, especially when we take into consideration the dilution law. To have (4) predominate we would have to have a very dilute solution, which is not the case in practice. It is not my intention to state that no Ni ions exist; but they are in a small amount. The actions that take place when the electric current is passed are numerous and very complicated. At cathode:

(1) Ni deposited by primary action.

(2) NH_4 ions migrate as a primary action and H evolved and NH_4OH formed by secondary reaction $NH_4 + H_2O = NH_4OH + H$

(3) Some Ni deposited by secondary reaction

$$2\,NH_4 + (NH_4)_2Ni(SO_4)_2 = Ni + 2\,(NH_4)_2SO_4$$

At anode:

(1) $SO_4^=$ ions migrate and dissolve anodes.

(2) $Ni(SO_4)_2^=$ migrates to anode.

. . . Some of the products of electrolysis, instead of acting on the anode and dissolving it, react with water, and the energy consumed in the migration of the ions is lost in actual work accomplished. Not so with a single salt solution, containing boric acid. The ionization is simple, and the products are simple and direct.

Another fact worthy of notice is that higher voltages are required to plate from double than from singe salt solutions. This is not at all surprising when one takes into consideration the amount of Ni ions present in solution. A certain force is necessary to set all ions in motion in the proper direction.

Since the Ni ions in a double salt solution are small, a greater force is required and must be maintained than if the Ni ions were present in greater amounts as is the case in a single salt solution."

The editor apparently felt that something required explanation, so he added (in bold-face type) this note:

(Authorities on electro-chemistry give the formula for the double nickel salt as $NiSO_4(NH_4)_2SO_4\ 6\ H_2O$. We leave it to our readers to decide if the nickel absorbs all the SO_4).—Ed.

Now if someone would kindly explain the explanation!

But for really original electrochemistry we must turn to a series of articles which have as their unifying principle the treatment of electricity as an element; and as before, it is necessary to allow the author to speak for himself, at some length. First, then, an essay on High Purity Nickel Anodes Versus Low Purity Anodes:

Since the double sulphate solution has been almost relegated to the discard in a great many of the progressive establishments, and solutions which deposit the metal more freely have been substituted, we need . . . [only] discuss the most efficient anode in the solution which will give the quickest and most satisfactory deposit.

"Repeated tests have shown the single salt . . . solution to be the most rapid in its action . . . when a salt or compound is added which deoxidizes and dissolves the oxide of nickel formed on the anode under the influence of the electric element. There is no doubt that the electricity forces its volume of oxygen out of combustions in the solution and takes its place. These elements which have oxygen combined may be hydrogen, sulphuric acid or the metal itself, and it depends entirely upon the volume of elements present, other than nickel, as to whether nickel is ironized;[3] also as to whether there is present an agent which combines with nickel and at the same time takes the electric element into combination with it.

Decomposing water by catalysis would throw the electricity to combine with the hydrogen only as long as there was free water present to supply the hydrogen. If the water is saturated with other compounds, then the electricity would combine with the element of compound having the greatest chemical affinity for it. This, no doubt, would result in freeing the hydrogen and electricity combining with it in the cycle of changes, as hydrogen has a powerful affinity for electricity in the presence of a catalytic compound.

[Platers who listened to Dan Gray's opening address at the 1950 Boston A.E.S. Convention on "Electrochemical Aspects of Photogenic Hydrolysis" should feel right at home here!—Ed.]

In the single salt solution . . . we could not combined the E with the sulphuric acid because it would be set free upon the cathode and would readily attack it if of iron, or any metal soluble in sulphuric acid or hydrosulphuric acid, making successful deposition impossible.

We can not combine nickel and electricity because the nickel would be set free upon a wet surface, and adhesion would be impossible under that condition.

It then remains to combine E with hydrogen only, or with some element or compound which would be a gaseous alkali [sic] at the cathode or would be instantly taken by another element and leave a chemical vacuum [sic] upon the cathode and the nickel deposited out of its combination to fill the vacuum.

In combining the nickel with the hydrogen only, the efficiency of the solution would be impaired because, if there were enough free water present to supply the hydrogen for a large volume of electricity, then the metallic content is necessarily low. Likewise, if the metallic content were high enough to deposit rapidly, the quantity of E would be necessarily reduced to prevent peroxide of nickel being deposited . . .

We must then look to some compound which will bring about a rapid cycle of changes and be automatic. Probably the best compound for this purpose is chloride of sodium . . .

We know that E displaces O at the anode. That is generally accepted. It is also generally accepted that Na is a good conductor of E, or in other words it will take E into combination with it. Then this is what happens:[4] E forces its volume of O out at the anode and at the same time forces Cl out of its combination with Na, acting as the combining influence for O and Cl, thus forming chlorous acid. As both sodium and hydrogen take E into combination, E unites with both and forms a compound which has not yet been named, but which might have the formula NaHE. . . .

I have stated that what might be chloric acid is formed by the electric current as a combining influence. As these two primary elements are so easily separated, the nickel anode would become oxidized by having a stronger affinity for the oxygen, and would be instantly forced out by E entering, and the nickel would be precipitated at the cathode, thus making the cycles complete.

Both chlorine and oxygen corrode nickel, and whether they attack it as a compound or as separate elements, the rapid disintegration of the anode is sure to follow. But as they do not attack carbon, then the low purity anode would only retard their action and result in the solution becoming impoverished in metal . . .

No solution could be made self-sustaining unless the volume of electricity is kept within the limits of the solvent for nickel. If there were a small proportion of sodium chloride in solution, and the electric element was raised above that volume, nickel would be deposited as both a primary and secondary reaction and no anode of any composition could be made to supply the metal as fast as withdrawn.

To maintain efficiency the catalytic agent and the electric element must be used in the right proportions, and the writer is frank to confess[5] that he does not know those proportions, depending altogether upon the appearance of the deposit to guide him in the use of the solution.

When it has been accomplished we will have 100% anode efficiency from pure nickel anodes and the 90 to 92% anode will be relegated to the discard."

Well, let's all go out for a smoke.

Now that you are back, we can continue with the author's explanation of his theory of electricity. In previous articles the element E has been used to explain electrochemical reactions; but feeling, apparently, that some justification for this procedure was required, the author made his theories about E more explicit, in an article called "Some Puzzling Equations with Which the Plater Must Contend." Like most of this writer's work, it cannot be paraphrased nor condensed; it cries for quotation:

"A majority of the platers contend that they do not need the knowledge necessary to solve the chemical problems in the plating room; that equations are only for the colleges and the laboratories. This is not a fact. Every plater . . . needs a certain knowledge of the fundamental principles underlying the operation of electrodeposition of metals. More than that he needs to know just what changes are taking place in his solutions if he hopes to match his wits against the subtleties of electricity.

Electricity, we are told, is a form of energy similar to light, heat, etc., but is it similar? Yes and no. It traverses various elements and compounds, changing some, not affecting others. So does heat for that matter. But heat will not combine with or traverse an element and leave it to go back to its source. Light penetrating certain transparent substances makes itself visible without undergoing any change. Not so electricity. While it may enter and permeate another element or a solid, its effect is not known until there is a circuit established whereby it may leave its conductor or compound.

We are told that an element must be of a nature that we can analyze, that it must be something that we can fix or confine. We can not hold electricity in combination with any known element — we can not fix it with any compound.

[3] *Normally one would interpret this as a typographical error. With this author, one can't be sure.*

[4] *Now we're getting somewhere. Or are we?*

[5] *At long last!*

True, we have stored it in cells, but the instant a circuit is established whereby it may travel around it leaves its combination. We are taught that the thunderbolt is a form of electricity. If this is true then we have evidence that this something which is so baffling forms, under the conditions of sudden condensation of vapors in a light strata of air, a body which is forceful and destructive, a tangible something that splits bodies with which it will not combine chemically. And again, we have evidence of it combining with solids, combinations of elements, and leaving no mark to indicate where it entered or passed out.

. . . We would like to know what there is in the equations as now given by chemists to help the plater arrive at a definite understanding of what is taking place in a plating solution? No one seems to care to take the E into the equation or explain what it really does, but since there can be no change take place in solutions without a reagent (and the electrodes are not supposed to react in solutions employing E from an external source) it follows that if electricity brings about the reaction it must be taken into consideration in reasoning from cause to effect.

. . . In the matter of copper sulphate solution (acid copper) the chemist will hand us an equation something like this: $CuSO_4 = Cu + SO_4$ at cathode. Of course, they explain, water is used as a solvent and the copper of the salt conducts (!) the electricity through to the cathode, but the plater who wishes to know the why of things gets no satisfaction. He gets none and he can not see how a combination of elements which merely conducts (?) electricity can fall apart and precipitate one or more of the elements. The idea is preposterous. But if we hand him an equation expressed thus:

$H_2O + 5\ H_2O{\cdot}CuSO_4 + E = H_2O + HE_2\ CuSO_3$ (+CuO on anode) in solution $= H_2O + E + Cu + SO_4$ at cathode

he would know that the water was the medium by which the copper salt and electricity are enabled to react to give the results desired. He would also know that $H + SO_3$ [sic] combined to form sulphuric acid and that no perceptible evolution of hydrogen takes place when the volume of E is kept within the limits of the decomposition strain[6] of the solution.

Contrary to the popular belief that the water of the solution is only a solvent for the salt and does not take any part in the arrival at the final result, from the chemists' point of view, the writer will consider the water as part of the electrolyte, as it no doubt reacts chemically with the salt or solids dissolved, as well as with the electricity. If the molecule of salt only served to 'conduct' electricity there could be no breaking up of the molecule and the separation of metal on the cathode. If the metal of the salt alone conducted the electricity, and the other elements were forced out there would be metal only deposited at the cathode when the electricity leaves it go back to the generator. But since we have abundance of evidence that other elements or compounds are deposited as a direct action of the reagent, electricity, we can but consider the compounds of those elements as the real electrolyte. In aqueous solutions the water no doubt reacts with the salt. In the electrolysis of a solution of common salt (which, by the way, is extensively employed in nickel plating solutions) we have hydrogen liberated on the cathode although the formula of the salt contains no hydrogen (= NaCl). It is well known that chlorine is evolved on the anode (or more properly the positive electrode) as is also oxygen. If the base of the acid only takes care of the electrical charge then the sodium would be the only element with which the electricity would combine. But since we see that hydrogen is liberated we must conclude that, since the chlorine has been eliminated, also the oxygen of the water (under the condition that only the value of the decomposition strain in electricity has been employed) E and Na combine chemically, since Na cannot exist except in an ascent state, in contact with water. Since it is well known that hydrogen is elvolved when water and sodium chloride is electrolyzed, hydrogen, too, must have combined in the molecule, and would assume the formula H_2ENa.

[6]*This author apparently cared little for the "decomposition strain" of his audience. This one statement alone probably accounts for the longstanding "undesireable" status of all chemists in plating rooms.*

We can not reconcile ourselves to the theory that the salt only is ionized, so the formula should be NaOH, as oxygen has been eliminated in its natural state and could combine only under a different formula, as when the current is increased greater than the actual value of the decomposition strain of the electrolyte, when ozone would be formed. Then taking this as a hypothesis we would write the whole scheme of the equation thus:

$$+ \quad \times H_2O + NaCl + E =$$
$$\times H_2O\ H_2ENa + ClO$$
$$- \quad \times H_2O + E + H + Na$$

It will be seen by this scheme that the water of the solution reacts with the salt (momentarily, to be sure) and that the Na set free at the cathode is not combined with the hydrogen, or at least one volume is not, and they, H and Na, force out the elements from their neighboring molecules, which in turn force out their neighbors, etc., across the entire electrolyte until there is union between Na + Cl + H_2O + O. It may be, and very likely is, a fact that Cl + E migrate toward the cathode to meet Na +H by chemical affinity, the interchange of elements occurring instantly. As these cycles are continuous while the electric element is passing through, there would be no exhaustion of any of the elements of the electrolyte provided the current strength was not raised above the decomposition strain, in which case other changes would take place.

Here . . . is the fallacy of the ionization theory. Every plater knows that metal begins to deposit from a dense solution at the instant electricity is conducted into it and yet, when excess current is employed, and hydrogen is evolved, the bubbles of hydrogen travel slowly toward the anode or come to the surface at the solution and explode. If there is truth in the theory of ionization, then we must conclude that oxygen is positively charged if hydrogen is negatively charged, and that they would travel toward each other with the speed of light and combine instantaneously . . ."

To do full justice to the author, it should be remarked that similar arguments against the dissociation theory were not unknown even in more august circles. But we had better look at the news once more.

Another one of those excursion steamer disasters occurred on July 5: the "Columbia" sank in the Illinois River near Peoria, with a loss of 200 lives. The Government took over the telephone and telegraph systems. Tom Mooney was granted a reprieve to December 13, and later his sentence was commuted to life imprisonment. On August 1, Joyce Kilmer was killed in action, bequeathing a legacy to elocutionists and parodists for years to come. U. S. intervention in the civil strife in Russia led to the declaration of a state of war between the two countries. Debs was convicted and sentence to ten years in prison. More serious than the fighting in Europe was an influenza epidemic which swept both the civilian and military populations: one out of every five soldiers had influenza and 20,000 died. The November elections gave the Republicans a majority in both houses of Congress — a situation which was ominous for the Democratic administration and its plans for the peace. For peace was in the air: overtures for an armistice had been made by Austria-Hungary and even the Germans had indicated they would not be averse to discussions. On November 7 bells rang and sirens blew across the nation, but the news of the end of the war turned out to be premature — the famous "false armistice" which should still not be mentioned in the presence of Mr. Roy Howard. The real one, on November 11, came as something of an anti-climax, although bells dutifully rang once more. Herbert Hoover went to Europe in charge of food relief, and on December 4 President Wilson set sail for Paris and the Peace Conference.

Abstracts of Papers Presented at the Electrochemical Society Meeting - October 11-13, 1950

THE fall meeting of the *Electrochemical Society*, held at the Statler Hotel in Buffalo, N. Y., featured a symposium on Electrodeposition and Metal Cleaning. Many of the papers were of direct interest to electroplaters, and these papers are abstracted in the following pages. There were also a number of papers on theoretical work which will be published by the Electrochemical Society in their Journal.

The symposium on electrodeposition was sponsored by the Electrodeposition Division of the Society, which also held its Annual Luncheon and Election of new officers for the Division. The following were elected to head the activities of the Electrodeposition Division for the coming year:

Chairman — *Dr. R. A. Woofter*
Vice-Chairman — *Prof. M. L. Holt*
Sec'y.-Treasurer — *Cloyd A. Snavely*

The above officers, plus *Drs. Abner Brenner* and *Ralph A. Schaefer*, were elected to the Executive Committee of this Division.

ABSTRACTS

Cleaning and Etching of Aluminum Alloys

By Dr. Walter R. Meyer, Enthone, Inc., New Haven, Conn.

In this paper the author discussed the various types of cleaning materials, such as solvents, emulsion cleaners, alkaline cleaners. Under emulsion cleaners he stated that the stability of emulsion test is not significant, as actually a quick-breaking emulsion provided better cleaning qualities. He cited graphite as being the most difficult material to remove from metallic surfaces.

In etching type cleaners, smut removal is often a problem. The most common etch cleaners use nitric-hydrofluoric acid mixtures. Polyethylene-lined tanks have proven most suitable for containing these mixtures. Frosting type etch cleaners utilize fluoride additions to the caustic base material to give a good white frosty color.

Non-etching cleaners for aluminum contain silicates in the caustic base to inhibit excessive attack. As silicate films remaining on the work may be troublesome, only enough silicate is used to inhibit the caustic attack.

Acid cleaners for aluminum are compounded mostly from phosphoric acid because of its slow rate of attack on this metal. Surfactants or oil displacing materials may also be added to provide wetting and solvent effects.

Diphase Metal Cleaning in Electroplating

By Foster Dee Snell and Irving Reich, Foster D. Snell, Inc., New York, N. Y.

In the removal of oily soils, three important factors are involved: preferential wetting, emulsification, and dispersion.

Diphase cleaning involves the simultaneous contact of the soiled surface by a water phase and an organic solvent phase. The solvent phase should also have dissolved in it an emulsifying agent. Most commercial diphase cleaners do not contain a single solvent, but are instead made up of a mixture of solvents for wider solution activity. The solvent phase provides preferential wetting of the metal surface, loosening and displacing the oily soil. This is then either precipitated or emulsified in the water phase.

A cleaning cycle using diphase cleaners which has proven successful commercially involves a soak in the hot diphase cleaner for 3½ minutes, spray for 90 sec-

A meeting of the Society wouldn't be complete without George Hogaboom and Dr. William Blum.

onds with hot diphase cleaner, spray rinse with mild alkali, and spray rinse with water.

The discussion following this paper brought out the fact that unless diphase cleaners are completely removed from the surfaces of parts they could be carried into bright nickel plating baths where they have been found to cause considerable trouble.

Water-Break Type Tests for the Evaluation of Metal Cleaning

By Samuel Spring, Pennsalt Research Laboratories, Wyndmoor, Pa.

The author first discussed the various complications of water-break tests, then described in detail a test developed to overcome these difficulties. This new test involves soiling a test panel, cleaning it under standardized conditions, then spraying the specimen with a finely atomized mist of water. Areas on which soil still remained showed up as well defined patches. The amount of area remaining soiled is expressed as a percentage of the total area. A cross-hatched, transparent plastic viewing box was used to facilitate area computations.

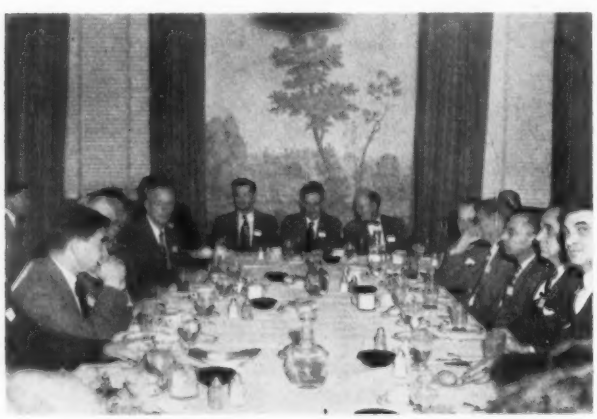
One of the interesting points brought out by the author was the fact that the time which elapsed between acid pickling and soiling the steel test panels markedly affected cleaning results. As much as 25% difference was found between specimens soiled immediately after pickling and those allowed to stand overnight before soiling; immediate soiling resulted in more complete cleaning under identical test conditions. Storage did not seem to affect un-pickled specimens.

The author concluded that this mist-spray test seemed to work best for almost or completely cleaned panels, which is the range of cleanliness of most interest to electroplaters.

Detection of Soil Removal in Metal Cleaning by the Radioactive Tracer Technique

By J. C. Harris, R. E. Kamp and W. H. Yanko, Monsanto Chemical Co., Dayton, O.

The authors first described the radioactive tracer technique, wherein test panels were soiled with materials containing a small amount of radioactive carbon



Luncheon of the Electrodeposition Division. At the head of the table are Drs. Ralph Schaeffer, Henry Linford, and M. L. Holt.

Robert Weast, of Case Institute, delivering his paper on Hydrogen Embrittlement. Dr. R. A. Woofter is moderator.

compound, cleaning the panels, then measuring the residual radioactivity.

In evaluating the relative sensitivity of various cleanliness tests to residual soils, these authors found their technique to be most sensitive, the common "water break" test next, then *Hogaboom's* copper sulfate immersion test, and last, the fluorescent dye-ultra violet light methods. They found that 2-2.4 $\times 10^{-6}$ gm./sq. cm. of remaining soil was the lower limit of sensitivity of the "water break" test.

(Editor's note—Complete details of the radioactive tracer technique are described in an article by *Mr. J. C. Harris* in the November 1950 issue of *Metal Finishing*.)

The Ascyclic Generator for Electrolytic Processing

By Gordon J. Berry, Electric Products Co., Cleveland, O.

A new type of generator was described which was capable of delivering up to 500,000 amperes of low voltage (up to 10V.) D.C. current. Seventy-five percent less mounting area for the same output, lessened installation and maintenance costs, and 10% higher efficiency than common generators were cited as reasons why this new type of generator would be widely used in electrochemical processes where very large amounts of current were necessary. The minimum practical size for this type generator was said to be 50,000 amperes.

Studies of Hydrogen Embrittlement of Cadmium Plated Steel

By Robert Weast, Case Inst. of Technology, Cleveland, O.

The effects of various cleaning, pickling, and plating conditions on the hydrogen embrittlement of SAE 1060 steel of Rockwell C 45-47 hardness was discussed in this paper. A bend test around a $\frac{1}{16}$" pin was used as a means of evaluation.

In pickling in various acid baths, the author found that inhibited conc. HCl gave least embrittlement (99% of original ductility remained), whereas more dilute HCl and sulfuric acids, both inhibited, gave more embrittlement. If the pickled parts were allowed to stand at room temperature for 11 hours, even those parts pickled in uninhibited acids recovered most of their

ductility. Raising the temperature increased this rate of recovery.

In cleaning by tumbling, finer abrasives gave the least change in the original bending strength.

Parts which were pickled and plated immediately lost over 40% of their ductility. In addition, the loss was permanent and the parts did not recover fully even after long aging. Tumbling followed by immediate plating, allowed the parts to recover most of their ductility in 16-20 hours at room temperature. If 24 hrs. were allowed to elapse between pickling and plating, and also between plating and testing, the parts retained 98% of their original ductility.

The author concluded that plating itself was not contributory to hydrogen embrittlement: only the amount of hydrogen absorbed entered into the case. They recommended tumbling as the best method of cleaning before plating. If pickling was mandatory, aging before plating proved least detrimental to ductility.

Electrolytic Hexagonal Nickel

By Ling Yang, Princeton University, Princeton, N. J.

Electron diffraction studies indicate that nickel deposits from all-sulfate baths (containing boric acid) were face centered cubic, but that deposits from all-chloride baths of equal molar strength in nickel gave a mixed lattice structure. In-between mixtures of chloride and sulfate produced first a change in orientation, becoming random with increased chloride, until finally the mixed lattice structure appeared at high chloride ratios. The mixed lattice was favored by low current density, low bath temperature, high chloride content; pH had no apparent effect.

The mixed-lattice nickel showed higher H_2 content (7-8 times as much, as proved by vacuum extraction and combustion to H_2O). The author pointed out that, although more H_2 is evolved in depositing nickel from sulfate baths than from chloride baths, less is found in the resulting deposits. Thus neither the amount of H_2 evolved nor the current efficiency are controlling factors in the amount of H_2 in the deposit.

In the discussion which followed, *Dr. Blum*, of the Bureau of Standards, stated that work under way at the Bureau of Standards indicates that there is also more oxide in chloride nickel deposits than in sulfate nickel deposits, and that the amount of this oxide seems to be more consistent than the H_2 content.

A chat between sessions brings together Dr. Faust, Dr. Linford, Dr. Schaeffer, and Dr. Lowenheim.

Scene at the Annual Luncheon, with Drs. C. L. Faust, Wm. Blum, and F. Lowenheim in the foreground.

The Effect of Indium in Electrodeposited Chromium

By Norman Hackerman and Tyleen Jensen, Univ. of Texas, Austin, Tex.

This paper described a new chromium plating bath containing indium which produced bright, adherent, ductile deposits of .002-.003" thickness that were crack-free, in contrast to the usual network-cracked deposit normally obtained from commercial chrome baths. The cathode current efficiency of the bath was between 10-15%, and current densities up to 20 amps./dm.^{2} (185 a.s.f.) could be used. About 1% Indium was in the deposit, which had a hardness slightly lower than commercial chromium plate. The authors speculated that the indium was present as hydrated indium oxide. The bath used contained 250 gm./l. of CrO_3, 2.5 gm./l. of H_2SO_4, and 38 gm./l. of $In_2(SO_4)_3$, with a CrO_3-SO_4 ratio between $\frac{103\text{-}110}{1}$.

The authors also found that pure chromium deposited by vacuum methods also had a network-crack structure. Indium-chrome alloys deposited in a similar manner were crack free.

Electrodeposition of Nickel-Rhenium Alloys

By L. E. Netherton, Victor Chem. Co., Chicago, and M. L. Holt, Univ. of Wisconsin, Madison, Wisc.

Baths for depositing alloys of nickel and rhenium were discussed. A bath containing 56 gm./l. of nickel sulfate, 66 gm./l. of citric acid, and 10 gm./l. of potassium perrhenate, at a pH up to 8, produced a deposit containing 80% rhenium at 70°C., 5 amps./dm.^{2} (45 a.s.f.), and 90% cathode efficiency. Other baths for cobalt-rhenium and iron-rhenium were given.

The nickel-rhenium deposits were bright, and remained bright even after 3 months exposure to the atmosphere. An outstanding characteristic was their excellent resistance to corrosion by concentrated sulfuric acid.

How to Alleviate the Shortage of Alkali Cleaners

By L. De Waltoff, *Chemclean Products Corp.*

ONE of the most irritating and troublesome results of the present shortage of materials is the stringency in alkalies. This condition has resulted in acute, and in some cases, critical situations in electroplating and metal finishing plants.

Even though some of the strikes which caused the shortage have been settled, it will take some time for the plants to resume normal operations, and even while operating at full capacity it will take some time for them to catch up with the built-up demand. It therefore behooves operators of electroplating and metal finishing plants to take steps to protect themselves in the interim, the duration of which is not definitely foreseeable at this time.

One of the methods which has been tried in the past to ease the load on alkali cleaners is the use of solvent emulsion cleaners. It is known, of course, that such cleaners cannot replace alkaline cleaners completely. The purpose of the solvent emulsion is to remove the heavy soils and to leave the work in a substantially cleaner condition, thus making it possible for the alkali cleaners to turn out a chemically clean piece of work in the minimum time and with the minimum consumption of materials.

The difficulties that have been experienced in the past were:

1. The dragging of organics into the plating bath from the solvent emulsions.
2. The formation of a soap film (soap forming a part of the generally used solvent emulsions) to form fatty acid films, especially in acid waters.

Recent improvements in the formulations of solvent emulsion cleaners have, however, eliminated these difficulties. By the use of new synthetic materials the solvent emulsions have been found to be stable in alkalies, free rinsing, and resistant to both acids and alkalies in water. Consequently, they do not foul the cleaning solutions, nor do they carry over into the plating bath.

By the practice of using a solvent emulsion precleaner, the heavy soils, oils, buffing compounds, etc., are removed more quickly and completely. Consequently, the alkali cleaner is enabled to work much faster, having a lighter load to carry. Even in normal times, when alkali cleaners were freely available, this cycle was definitely advantageous. However, under present conditions, it is almost indispensable, since it takes a large part of the load off the alkali cleaner, giving it much longer life by reducing the consumption of the scarce alkalies.

It is especially noteworthy that the use of solvent emulsion cleaners is highly effective in removing buffing compounds, always a difficult operation.

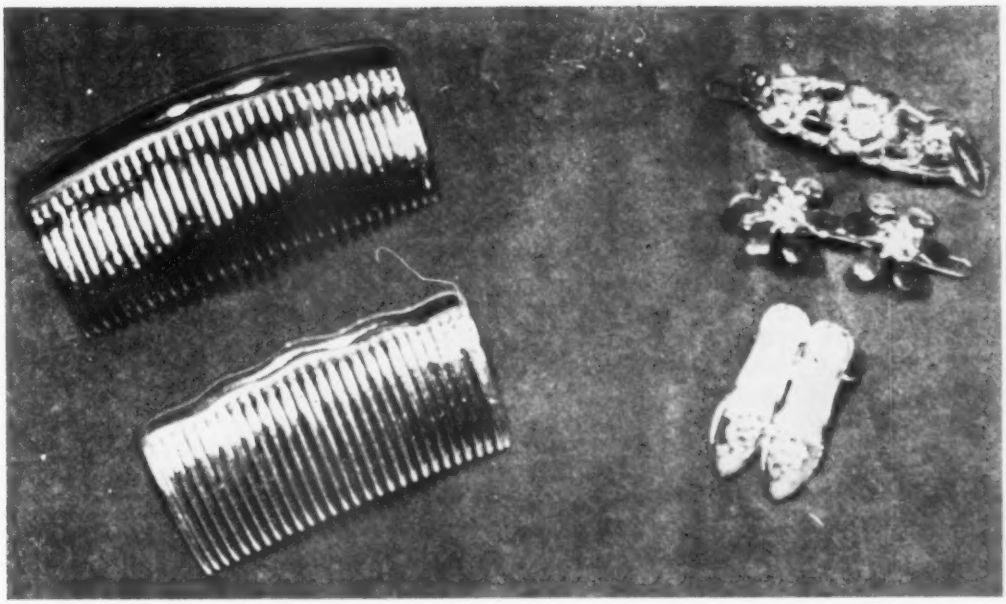
EVALUATION WASTES

(*Continued from page* 55)

concentrations of nickel salts are actually advantageous in sewage treatment processes.[30]

3. *Chromium.* While the acid content of chrome plating solutions is high, the most objectionable material present is not the acid, but rather the chromate ion. Chromates have been known to seriously interfere with the operation of biological sewage treatment plants, and are therefore highly objectionable from the sewage treatment point of view. Chromate has also been known to cause damage to fish life in streams, and solutions containing appreciable quantities of this material should not be discharged without treatment. Treatment of this material will include reduction of the chromium from the hexavalent form to the trivalent form by the use of such materials as ferrous sulfate, sodium bisulfite, sulfur dioxide, barium sulfide, metallic iron, etc.[16] Following reduction of the chromates, the solution should be neutralized to eliminate free acid. At this point the chromium salts will be precipitated and may be removed for further processing if desired.
4. *Zinc.* Zinc plating solutions are composed of zinc cyanides, together with an excess of sodium cyanide. The solutions are therefore predominantly alkaline and have a high cyanide content. Treatment involved will be destruction of the cyanide by one of the methods mentioned above, and neutralization for the removal of zinc.
5. *Cadmium.* Cadmium plating solutions are similar to the zinc plating solutions with the exception, of course, that cadmium is used in place of zinc. The solutions are highly alkaline and of a high cyanide content, and therefore require treatment similar to that for the zinc plating solutions.
6. *Tin.* Solutions used for tin plating in automotive practice are strongly alkaline in character, and contain sodium stannate, sodium acetate, and sodium perborate. Little difficulty should be experienced from rinse waters following these baths, nor should any trouble be encountered from the prudent disposal of concentrated solutions directly to the plant sewer. If recovery of the valuable metal cannot be practiced, then the solution should be kept in a retention tank and bled slowly to the sewer system.

(*To be continued in next issue*)



Some of the many plastic items finished by means of silver mirror spray methods.

Silvering Plastics

By Isidore Cross, New York, N. Y.

Mr. Cross comes from a family of platers, his father having devoted 40 years to the trade. He is a graduate of C.C.N.Y. and Brooklyn Polytechnic Inst., and started in the plating field in 1937 with the Henry Nelkin Co. He subsequently was finishing supervisor of Turner & Seymour Mfg. Co., Torrington, Conn., and in 1945 opened his own job plating plant. He is now associated with H. Goodman & Sons, N. Y. C., as chemist and plating supervisor.

DEPOSITING a silver mirror on a non-metal, and in some instances on a metal, is not a brand new development in the realm of finishing. The few references to this method for finishing plastics are in the patent literature and in a few offhand remarks made in some of the many reviews on the metallizing of plastics.

The use of a silver mirror on plastics as a commercial finishing operation dates back to the late "thirties." In 1921 *Blasius Bart* applied for and received Patent No. 1,574,544 employing a method similar to the one to be described; his "highly reflective" silver surface was merely a conducting film to be plated over with acid copper, and was not used for the ultimate finish. Today, the reduced silver mirror is a very strong competitor to plastic items which have been given the full treatment, (i.e. a heavy copper base for subsequent finishing.)

While the mere deposition of a silver mirror on a non-metallic cannot ever completely replace that method of depositing a heavy copper plate on the plastic, by the use of dyes many metal finishes can be easily simulated. Important drawbacks to this process are that not all plastics can be treated by this method, and the wearing qualities of this finish are not as good as the regularly plated articles.

The general idea behind depositing a silver mirror on a plastic is to give that non-metal a metallic appearance, by-passing costly plating operations and saving time. In this instance, a front-surface mirror is formed on the plastic, and the protecting film of lacquer over the mirror is dyed gold, copper or any other color desired. Chromium, nickel, and other decorative finishes cannot be simulated.

This paper covers two methods of obtaining a mirror; one method is to spray, simultaneously, ammoniacal silver nitrate and a suitable reducer through a dual-nozzled air gun, and the other method is by immersing the articles to be silvered in a solution containing ammoniacal silver nitrate and reducer.

The spray process was first used commercially about 1935 when *Schneider* applied for and received Patent No. 2,136,024 (1938) for a dual-nozzled gun, and received further impetus when *Peacock Laboratories* of Philadelphia took out several patents (Nos. 2,214,476 and 2,337,282) describing processes and machines for the spraying of glass mirrors with a dual-nozzled gun.

A clean surface, as with almost every finishing process, is of utmost importance; knowing the material you're working with is equally as important, for not all plastic can be metallized by this process.

Sealing

To insure a clean surface, the plastic is usually first lacquered with a sealer. The sealer or undercoat has several purposes; one is cleanliness, and another is to seal in the plasticizer and other volatile ingredients of the plastic so as to insure consistent results. Since the mirror is a surface phenomena, using the same sealing lacquer on all types of materials will give a consistent

product. Often, the same type of plastic will not be uniform as to plasticizer content or type of plasticizer used; this may affect the quality of the mirror, hence for consistency a sealer is necessary.

The sealing lacquer must have gloss and "body." This qualification is equivalent to the polish on a metal just prior to plating; just as the degree of polishing determines the final finish on a metal, the gloss and "body" of a lacquer determines the kind of a finish one can expect on the plastic.

The solvents in the lacquer must not attack the plastic, and the lacquer must be firmly adherent. Herein lies a rub; not all plastics can be lacquered, and not all plastics can be sealed with the same type lacquer. Polystyrene is a notorious example. Most lacquers attack polystyrene by wrinkling its surface. Lacquers have been formulated for the purpose of adhering to polystyrene and not attacking it, but a protective top coat must be applied to the silver mirror, and a top coat must be used that will form compatible layers with the polystyrene sealer.

This all leads us to the next problem, which, while it is not the next step in the process, deserves the next consideration. The top coat of lacquer, the protecting coat over the silver, must be so formulated that there will be no solvent action or otherwise adverse reaction on the sealer, and be at the same time firmly adherent to it. The silver mirror is extremely thin and is not at all homogenious; actually, one coat of lacquer is being put on the other. The slightest solvent action will cause the mirror to be disturbed and a wrinkling to take place; this wrinking is commonly referred to as "crazing." Most air-dry lacquers will affect the coating in just that way, and in order to avoid that condition a low-bake thermosetting lacquer as a sealer has been suggested. This thermosetting sealer, when fully converted, will be little affected by most lacquers used as top coats. Another function of a thermosetting material is that it minimizes the migration of plasticizer from the plastic to the outer lacquer. If a thermoplastic material is used for a top coat and plasticizer migration does take place, the outer film will become tacky and soft. Plasticizers have a tendency to migrate from a material of a higher concentration to that of a lower one, and plastics generally have a higher concentration of plasticizer than do lacquers. Some plastics like polystyrene do not contain any plasticizer, but that does not come under the scope of this article.

Preparation for Silvering

The plastic items are racked, and not unlike a number of well-advertised food items, they remain

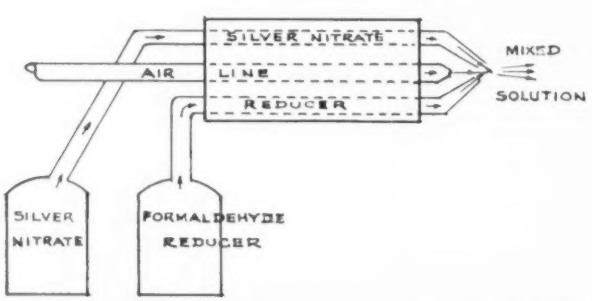


Figure 1. Sketch based on Schneider's patent showing how solutions are mixed after leaving gun.

"untouched by human hands" until the unracking process. A suitable lacquer is then applied by spraying or dipping, and allowed to dry thoroughly. Since this first coat of lacquer is really the finishing surface, it should, among other requirements, impart a very high gloss to the articles. In cases where the plastic has an excessively high amount of mold parting compound, the plastic must undergo a preliminary washing in a compatible solvent prior to lacquering in order to insure maximum adhesion between the plastic and the lacquer.

The plastic is now ready to receive a reduced silver film which can be obtained (a) by spraying with a dual nozzled spray gun, or (b) by immersion in a silvering solution. The preparation prior to the reduction by either method is the same.

The work is then put through a ½% to 1% solution of a wetting agent and thoroughly rinsed in tap water.

The purpose of this step is to wet the surface, making it free from water breaks. A thorough rinse is absolutely necessary because the next step involves an

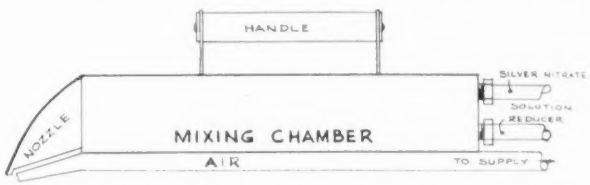


Figure 2. Sketch of Bart's original gun, taken from a patent filed in 1921. Partially reduced solution emerged from a pinhole opening in the nozzle as a fine mist.

acidified solution, and the alkaline wetting agent will contaminate it. Sodium lauryl sulphonate is a good wetting agent for this purpose; many others may do just as well.

After completely rinsing the wetting agent, the work is sensitized in a solution consisting of about 10 grams of stannous chloride and 16cc of hydrochloric acid per liter of distilled water.

The stannous chloride must be thoroughly dissolved and the solution clear. The purpose of the hydrochloric acid is to dissolve the stannous chloride and render a clear solution, as tin chloride by itself is insoluble in water, but is soluble in an excess of HCl. The function of the tin is to sensitize; how this phenomenon occurs is a matter of conjecture among several different theories, but omit this step and invariably no silver mirror will be produced.

The sensitizer contaminates rather easily and could be a source of trouble. This contamination will show up in the final product as dull spots and streaks. The solution should be changed often to minimize contamination; the low concentration of the ingredients makes this practice economically practical.

The stannous chloride solution must be washed off completely, otherwise the subsequent silver deposit will appear white, not unlike a burnt electrodeposit of silver. To economize on distilled water, the stannous chloride can be rinsed off in ordinary tap water and then sprayed with distilled water just prior to silvering.

Silver Spraying — Dual Gun Method

As related earlier in this article, patents were applied for by *Blasius Bart* in 1921 and 1920 and issued in 1926 as Nos. 1,54,544 and 1,583,268 for a dual-nozzled

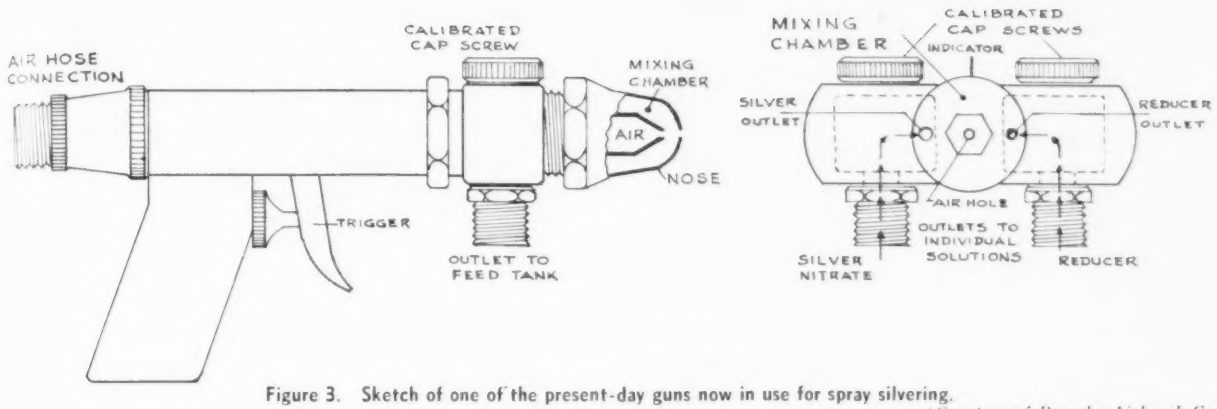


Figure 3. Sketch of one of the present-day guns now in use for spray silvering.
(Courtesy of Paasche Airbrush Co.)

gun to silver reflector moulds prior to electroforming. The gun was a crude affair compared to the ones available today, but the basic principle was the same and Bart claimed that a bright reflecting mirror could be obtained. Crude as was his gun, Bart was fully aware of the part that speed of reaction played. His patent also called for the spraying of a cloud or a mist of reduced silver nitrate on to a mould. He used Rochelle salts and formaldehyde as his reducers and silver nitrate as his source of silver. The gun had what he called a "mixing chamber" where the silver solution and the reducer were mixed just long enough to partially reduce the silver before emerging from the gun on to the work. Bart regulated the amount of chemicals used by turning the valves controlling the volume of the different solutions. He sprayed at room temperature. Though he used this process for a slightly different purpose, Bart can truly be called the pioneer for silvering by this method.

In 1935, *H. Schneider* applied for a patent which he received in 1938 as No. 2,136,024. Schneider's claims were diametrically opposed to Bart's as far as gun design and technique were concerned. Schneider shot a stream of liquid on to his work instead of a fog; whereas Bart's gun had a mixing chamber for the chemicals, Schneider's had the two streams converge and mix in mid-air just before impinging onto the work. Schneider used his process for the purpose of obtaining a mirror on glass or plastics.

In 1938 *Peacock* applied for Patent No. 2,214,476 (1940) which concerned itself with the making of glass mirrors using a dual-nozzled gun. This patent, assigned to the *Peacock Laboratories* of Philadelphia, Pa., is, in the author's opinion, the most pertinent method for finishing plastics. The solutions have brief contact in the head of the gun, emerging mixed and slightly reduced, embodying the principle set forth in Bart's patent. The solutions pertinent to this process are also given in the patent. Peacock's method for silvering glass could be readily applied to plastics with but a few modifications in procedure.

The dual-nozzled gun is just what its name implies. It is an ordinary spray gun with two feed lines leading from two separate jars or tanks instead of the customary one, as in lacquer spraying. The head of the gun contains two calibrated cap screws; these screws adjust for the individual volumes. The adjusted volumes pass through individual holes to the nose of the gun where they come in contact with each other. The mixed solutions, with the silver already partially reduced, comes through a single opening in the gun.

The several patentees have described techniques involving the use of their guns and have made claims for their patent on that basis. One suggested the use of a fog; another suggested that a stream of solutions, forcused to mix past the gun opening, impinge on the work. There is a certain technique in using the gun; however, no definite technique can be prescribed. The author's opinion on this subject is that any way of spraying is fine as long as good, consistent results are obtained. Equally good results were obtained from a fog-like spray, or from a stream of liquid impinging on the work. The results actually depend upon the composition of the solutions used, the ratio of their volumes used (reducer to silver), and concentration. The ratio between volumes can be changed by adjusting the cap screws situated in the head of the gun that control the volumes of the individual solutions.

The use of equal volumes is to be desired, so that both solutions can be replenished at the same time; hence concentrations are adjusted so that volume for volume of solutions are used.

Silvering Solutions

Concentrations found to give the best results are 10-12 grams of silver nitrate and just enough ammonia to dissolve the precipitate formed, per liter. The addition of three to four drops extra of ammonia per liter is good practice. Ammonia is one of the factors controlling the rate of the reaction. A lack of ammonia, evident by a hazyness of the solution, will give too fast a reaction, resulting in a fogged mirror; too much ammonia will retard the action so that no mirror will form.

In actual practice concentrated stock solutions are used. Concentrations of six to ten times the working concentration are convenient. The stock solution should contain a slight excess of ammonia to keep the silver in solution on long standing; a solution of straight silver nitrate at spraying concentration should be on hand to back titrate the excess ammonia in the diluted solution to a cloudiness, and from that point on the four extra drops of ammonia are added.

The selection of a proper reducer is very important to the success of the process. Reducers are made to fit the process; since the speed of reduction to form a mirror by the spray gun method must be taken into consideration, different reducers are used for different methods. Reducers like the sugars and Rochelle salt are much too slow for this process. Formaldehyde at

high concentrations reduces too quickly and a grayish, dark film of silver results, good only to receive an electrodeposit of acid copper. A dilute solution of formaldehyde, 8-10 cc. per liter of distilled water, is a good concentration for spraying.

Caustic potash or soda is generally added to accelerate the reaction. The caustic may be added to either the silver nitrate solution or to the reducer with the same effective results. The author much prefers the addition to the reducer; on long standing, the caustic will cause the silver to precipitate as the oxide, thus darkening the solution. Moreover, when dry the silver alkali salts are explosive mixtures.

Peacock in one of his patents suggests the use of the hydrazines, either as the chloride, sulphate or nitrate as reducers, the recommended concentration being 2 oz. per 100 oz. of water of the hydrazine with the addition of a ½ oz. of caustic soda. The author found that a 50-50 mixture of 20 grams per liter of hydrazine sulphate with 12 cc./liter of formaldehyde, and 6 grams of caustic added to each solution, was a very effective reducer. Stock solutions of higher concentrations should be made up and stored.

The background reflected from the mirror should be an indication of the quality of the product. If the ratio of reducer to silver nitrate is too great, then the mirror will have a yellowish background; with a reverse ratio, the background tends to be blackish. A proper background is white.

After the mirror is formed, the work is immediately sprayed with a stream of distilled water and then dried. Drying is accomplished by blowing a draft of warm air over the work. A suitable lacquer is then applied to protect the mirror. When the top film of lacquer is dry, the article is dyed to any color or shade desired. The dyeing may also be accomplished with a colored lacquer.

Immersion Deposition of Mirrors

The preliminaries prior to the application of a silver mirror by immersion are the same as described for the spray process.

Figure 4. Photo of a modern spray silvering gun for metallizing plastics or other non-conductors. Note the two calibrated cap screws for adjusting the volumes of the two solutions, and the mixing chamber in the nose of the gun. Air line is connected at rear (right end) of gun.
(Courtesy of Paasche Airbrush Co.)

This process too has important variables that must be taken into consideration. The amount of silver nitrate used is a function of the total surface area, though only an approximation of the area is necessary. Another important consideration is the limiting dilution factor for the silver nitrate. It was found that about 1.1 gram of silver nitrate per liter of water was the limiting dilution permitted for obtaining a mirror. In other words, it takes so much silver nitrate to produce a bright silver mirror over a certain area. If the concentration of silver nitrate necessary to cover that area is less than 1.1 gram per liter, then a good mirror will not be obtained. As far as the author's experience is concerned, it was found that when silver nitrate concentrations of 2.5 grams per liter, or higher, were required, superior mirrors were obtained.

A formula modified from the Brashear formula suggested by *The National Bureau of Standards Circular #983*, 1931, is among the best for this process. The following are the necessary stock solutions.

REDUCER

Cane Sugar (or equivalent)	90 grams
Nitric Acid, c.p.	3 drops
Water, distilled	1 liter

Boil the above for ½ hour and then add 175 cc. of denatured ethyl alcohol as a preservative. The boiling of the slightly acidified sugar water is called inversion; the cane sugar, a disaccharide, is inverted to the monosaccharides, glucose and fructose, which are active reducers.

Sugar, not very effective as a reducer for the spray method, is an excellent reducer for the immersion process. The use of just that amount of sugar that will reduce a definite quantity of silver nitrate results in a beautiful mirror. Though the rate of mirror formation is much slower than with the spray method, by the use of a large enough processing tank, an equivalent amount of work can be processed in the same time it would take to spray it.

SILVER SOLUTION

Silver Nitrate, c.c.p.	125 grams
28% Amonium Hydroxide, c.p.	175 cc.
Water, distilled	to make 1 liter.

The ammonia is more than just that amount to keep the silver in solution, but this excess prevents the silver from precipitating on long standing. Other necessary solutions are:

Sodium or Potassium Hydroxide ... 25 grams/liter.
and
Silver Nitrate ... 50 grams/liter.

All the chemicals used are of the highest purity and the water is distilled or de-ionized.

The function of the caustic is to accelerate the reduction just as in the spray gun process. The silver nitrate solution is used to back-titrate the excess ammonia from the stock solution, and should be the exact concentration of the ammoniacal silver nitrate at diluted working strength.

Caustic is used at half the concentration for silver nitrate; thus with a working concentration of ammoniacal silver nitrate of 50 grams/liter, the caustic is 25 grams/liter and equal volumes are used. This mixture

is at its optimum when the color of the mixed solution just darkens; to attain this and satisfy the other condition of concentration, the excess ammonia must be adjusted with the plain silver nitrate. This is best determined empirically. A working solution of 50 grams/liter of ammoniacal silver nitrate is made by taking 400 c.c. of the stock solution and diluting to a liter, using distilled water. Seventy-two c.c. of the plain silver nitrate (50 gms./liter) was found to be sufficient to counteract the excess ammonia so that equal volumes of the silver and the caustic will just darken on mixing.

The working concentrations chosen are those that give the process its greatest flexibility; dilute enough so that a few c.c.'s more or less doesn't make any difference in the quality of the results. If solutions of stock strength were used, such flexibility couldn't be attained, and if the solutions used were more dilute, greater volumes would have to be handled, an inconvenience in itself.

The ratio of reducer to silver nitrate was found to be 1 gram of sugar to 3 grams of silver nitrate. Roughly, 3 grams of silver nitrate covers 1 square foot of plastic surface, that is, all surfaces that receive the mirror. Racks must be taken into account when areas are calculated. [In trying to determine which method used more silver, tests were run and it was found that the amount of silver used for each method was amazingly identical.]

After sensitizing, the work is thoroughly rinsed and dipped into the processing tank filled with distilled water. The dimensions of the tank must take into consideration the limiting minimum concentration of the process. This factor should control the size of the racks, thus the more work put on the racks for a given area, the better will be the results.

The calculated amount of silver is mixed volume for volume with the caustic potash and put into the tank. The work, gently agitated, mixes the solution; the reducer is then added last. The processing time should take about two and one half minutes, or the time it takes the black solution to turn a creamy color. The rack is then withdrawn, sprayed down with distilled water and further rinsed with regular tap water. The processing solution is discarded for refining after each batch of work; it cannot be used more than once.

An indication of how the work will look when finished is gotten by observing the wet work. If the work is bright and shiny, without a fog, it will look the same when lacquered, as usually all silvered work, when dry, looks very good despite a fogginess when wet.

The appearance of the silver mirror is affected by varying conditions, going back as far as the wetting agent, which may not have wet completely, to the stannous chloride which didn't sensitize properly due to impurities. Generally, a splotchy mirror is due to bad wetting; stains and poor coverage are the fault of the sensitizer, and a white powdery deposit is usually associated with using too much silver for the area to be covered. A yellowish deposit is a sign of too little silver.

After the mirror is obtained, the work can be dried in a current of warm air. One of the most difficult aspects of this process now comes to hand — the application of a proper top coat of lacquer. As explained earlier in this article, the top or finishing coat must be compatible with the sealer. If the top coat has even the slightest solvent action on the sealer, the silver will wrinkle or craze, losing its reflective qualities, luster, and adherence. It has been found that a combination of low baking, thermosetting lacquers are particularly helpful in obtaining excellent results; and low baking doesn't mean the use of force-drying materials.

Silvering Equipment

For mirroring with a dual-nozzled gun, it is best to use a spraying technique throughout, except for sensitizing. The sensitizing process is a dip. The booth used should have a drain for the water used, which in turn should be treated for the recovery of the excess silver from overspray. The excess silver can be treated with muriatic acid and sold to the refiner as silver chloride. The booth should be coated with a good corrosion resisting paint.

The immersion method requires the use of tanks, and with the exception of the silvering tank, steel coated with a good corrosion resisting paint is good enough. The silvering tank is preferably of ceramic and should be equipped with a drain, for after each batch, a new solution has to be made up. The reason ceramic is used for the silvering tank is that nitric acid is one of the most effective agents for cleaning silver compounds, and no organic coating can withstand its attack for very long.

The recovery of the silver is of prime importance as far as the economic aspects of the process are concerned — therein lies the profit.

This process has many applications, and with the high cost of finishing today, this method is being more widely sought. The top coat of lacquer can be dyed any color, and gold and copper dyes are used to simulate those metals very successfully. An interesting sidelight on this process is that many metal items are processed in this manner. Raw castings and stampings are coated with a heavy glossy lacquer, making in effect a plastic of the metal; then it is processed as if it were a plastic. The effect is startling . . . and economical.

Shop Problems

Abrasive Methods—Surface Treatments—Control
Electroplating—Cleaning—Pickling—Testing

METAL FINISHING publishes, each month, a portion of the inquiries answered as a service to subscribers. If any reader disagrees with the answers or knows of better or more information on the problem discussed, the information will be gratefully received and the sender's name will be kept confidential, if desired.

Patina on Silver Plate

Question: We understand that the "patina" imparted to silver plated ware plays an important part in the resistance of such ware to tarnishing, and would appreciate any information that you can furnish on this patina and how it is created.

O. A. A.

Answer: The term "patina" in connection with silver plated ware refers to the very fine scratch pattern left after the final buffing and coloring operations, which are performed after the parts are plated. It does not have the same meaning as the patina formed on copper base metals by natural aging or artificial chemical treatment. In the latter case the patina is a chemical compound formed as a result of corrosion of the metal.

For certain items, especially table flatware, the patina finish seems to be preferred. On other items the unscratched, brilliantly lustrous finish, such as would be produced by electropolishing, is desired. There is no evidence to the effect that the "patina" finish helps prevent tarnishing of the silver plate.

Bright Nickel Scratch Finish

Question: We have seen a finish on our competitor's items that is new to us. The best description of it would be a bright scratch finish, as there are definite scratches underneath, yet the nickel plating seems to be quite bright and shiny, as though it were buffed or colored. We would appreciate any information you might have on how such a finish is produced. We regret that we cannot send you a sample, and hope that our description will enable you to give us this information.

N. B. L.

Answer: From your description it would seem that the finish was produced by plating bright nickel over a polished but unbuffed base. You can re-produce this by using as a final wheel polish a #220 or finer greased wheel. If the base metal is steel, this would be followed by a flash of copper, then plated from a bright nickel bath. On copper alloys the bright nickel would be plated direct. Finer scratch patterns can be produced by using finer abrasives in the final polishing step. A little experimenting along these lines should produce the desired results.

Corrosion Resistance of Black Oxide Coatings

Question: We have been considering changing from a cadmium plated finish on some steel parts to a black oxide finish, due to the uncertainty of obtaining sufficient cadmium. One of the problems involved is in the resistance to corrosion offered by the oxide finish as compared to the cadmium. Can you give us any figures on this that we can use as a guide?

T. F. A.

Answer: You did not mention the thickness of cadmium plating involved, therefore it is impossible to give any comparative figures. Assuming a normal min. commercial thickness of .0003", you could expect a salt spray life of 200 hours for cadmium plating. The salt spray life of black oxide coatings alone, without any oil or wax overcoat, would only be several hours. However, with suitable oil or wax coatings the salt spray life can be increased many times, depending on the type of coating and its thickness. Manufacturers of the various commercial blackening baths can recommend suitable after treatments that will provide a good serviceable corrosion resistance to the black oxide coatings. If corrosion resistance is the primary requirement it would be advisable to make comparative tests before changing the finish. Zinc plating is another possible substitute in this case, provided that the zinc anodes and chemicals are available in sufficient quantities. Zinc plating of equivalent thickness would have a service life about equal to cadmium plate under most circumstances.

Etching Agents for Electrodeposits

Question: In using the microscopic method for determining plating thickness we are often bothered by a lack of contrast between the deposit and the base metal, which renders accurate measurement difficult. We have heard that there are etching agents available to eliminate this problem, and would appreciate your sending these formulas along to us.

M. S. J.

Answer: The following etching reagents have been found suitable for plated deposits on steel:

1. Nickel on steel—reagent etches steel base metal
   Nitric acid (conc) 5 volumes
   Alcohol 95% 95 volumes
2. Nickel on Copper—reagent etches the copper
   Ammonium Hydroxide 1 vol.
   Hydrogen peroxide 1 vol.
3. Zinc or Cadmium on steel—reagent etches the deposit
   Chromic acid 200 gm./l.
   Sodium sulfate 15 gm./l.
4. Lead on steel
   Ferric chloride 10 gm.
   Hydrochloric acid 2 ml.
   Distilled water 95 ml.

Other suitable etching reagents may be found in any good text on metallo-

graphy or in *Metals Handbook* (American Society for Metals).

Sealing Anodized Aluminum

Question: We are interested in finding out about various sealing treatments on anodized aluminum alloys, especially as regards their relative protective values. Can you tell us anything about this or refer us to any publications that might be in a position to advise us?

F. L. T.

Answer: The September 1948 issue of *Metal Finishing* contained a reprint of a comprehensive study by *L. Whitby* on this subject, to which we refer you for details. He reported on silicates, nickel and cobalt salts, and various chromate and dichromate treatments with relation to salt spray resistance.

Calculating Areas of Bowls of Spoons

Question: In calculating the thickness of silver on tableware we are always troubled by the calculation of the total surface area of the bowl of the spoons. Is there any known way of simplifying this calculation by means of more easily measured values? Any information will be appreciated.

G. S.

Answer: For the bowls of spoons it has been found by a series of measurements that the area on each side of the bowl is approximately equal to that of an eclipse, the two axes of which are equal to the length and width of the bowl. That being the case, the formula

$$a = \frac{\pi lw}{2}$$

would give the total area of both sides of the spoon. In the above formula

$\pi = 3.14$
l = extreme length
w = extreme width

Federal Specification RR-T-51a, copies of which are available from the *Supt. of Documents, Washington 25, D. C.*, gives a detailed treatment of the above calculations and many others for figuring the weights of silver plating on tableware.

Bower-Barff Finish on Steel

Question: We have had an inquiry from one of our customers for a Bower-Barff finish, but we have never heard of this finish and would appreciate any information you could send us on it. The parts are flat steel hinges.

J. C.

Answer: The Bower-Barff finish is one that was popular many years ago, but has now almost disappeared from commercial use. It is essentially a black oxide finish on steel, but instead of being done in a chemical bath the oxide is produced in a furnace at high temperature under special oxidizing conditions. The parts are subsequently oiled after the furnace treatment. The finish is a very durable one, especially for indoor applications. Temperature in the oxidizing furnace is about 1,700°F., so the process cannot be used on parts that would be softened excessively at this temperature. While the parts are at temperature, live steam and carbonaceous gas, such as producer gas or tar vapors are introduced into the furnace atmosphere to form the coating. The process works very well on cast iron as well as steel. Parts being treated must be placed in the furnace in such a manner as to expose all surfaces to the oxidizing conditions if a uniform color is desired. A muffle type furnace is required, so that the steam and gas can be introduced without mixing with gasses or products of combustion in the furnace.

Pre-Polishing Brass Strip

Question: We are polishing extruded brass strip prior to bending it to shape to form picture frames. We are experiencing a definite roughening at the bends which is objectionable, and wonder if there is anything we can do to eliminate the touching up on a buff that we now are doing to make these parts passable.

R. W. C.

Answer: About the only thing you can do is to be sure that the brass stock has a fine grain size when you purchase it. However, there is a limit to the fineness of grain you can use, inasmuch as a very soft metal is required to withstand the sharp bending involved, and softest metal in brass is usually associated with fairly large grain sizes. We suggest that you contact your supplier to see if a compromise cannot be worked out on the grain size of your brass strip.

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PATENTS

Buffing Wheel

U. S. Patent 2,506,288. *H. H. Bahr, assignor to Guaranteed Buff Co., Inc.*

A buffing wheel comprising a disk, means for mounting said disk on a shaft, a plurality of spaced pins secured to said disk adjacent to the periphery thereof, a plurality of sets of pieces of fabric secured together at one edge by staples, the ends of said staples fitting over said pins.

Plating Thickness Measuring Instrument

U. S. Patent 2,507,529. *S. Lipson.*

For measuring the thickness of a coating carried by a basis material having magnetic characteristics which differ from those of the coating, the combination in a measuring instrument including a solenoid, a reference support for said solenoid permitting axial movement of the solenoid therealong, a magnetic core within said solenoid free to move axially with respect thereto, means for holding said solenoid with one end of said reference support and of said core in contact with the surface of the coating to be measured, means for energizing said solenoid whereby to magnetize said core and magnetically attract its said end against said coating's surface, means for moving said solenoid along said support away from said surface whereby to build up the solenoid's magnetic pull on said core until separation thereof from the surface is effected, and means for indicating the solenoid's spacing from said coating surface at the instant of said separation whereby to provide a measure of said coating's thickness.

Chromate Treatment for Aluminum Alloys

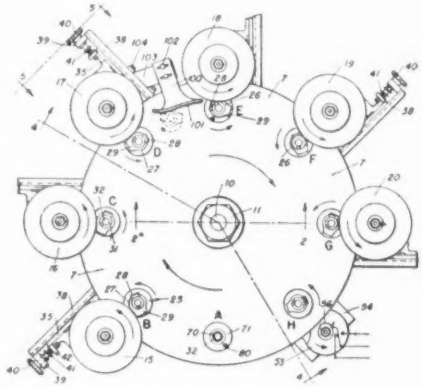
U. S. Patent 2,507,956. *M. H. Bruno and P. J. Hartsuch, assignors to Lithographic Technical Foundation, Inc.*

In a method of coating aluminum or aluminum alloy surfaces to form an adherent, corrosion-resistant coating thereon without the evolution of gaseous hydrogen, the step which comprises subjecting the surface to the action of an aqueous coating agent having a pH of less than 3 but sufficiently high numerically to avoid the evolution of gaseous hydrogen and consisting essentially of water, an amount of hydrofluoric acid stoichiometrically equivalent to 0.25 to 11 grams of gaseous hydrogen fluoride per liter of solution, and from 10 to 350 grams per liter of ammonium dichromate, the amount of hydrofluoric acid being low when the amount of ammonium dichromate is low and high when the amount of ammonium dichromate is high but within the ranges indicated.

Rotary Indexing Table for Automatic Polishing

U. S. Patent 2,507,998. *I. H. Russell, assignor to Sloan Valve Co.*

In an automatic machine for processing work pieces having irregular body contours, a work table having work piece supporting means arranged at intervals around said table, intermittent driving means for indexing said work table to position said work pieces into different stations, work performing means arranged opposite each station of said work table, a main gear including pawl and ratchet mechanism for axially rotating each work piece at each station while the work performing means is operating upon the work piece, the axial rotation of the work piece being less than one complete revolution, and means for axially rotating said work piece to its initial axial position during the time said work piece is being indexed by said work table between stations, said last means comprising an arrangement whereby said intermittent driving means rolls said work piece supporting means along said main gear while said main gear is stationary.



Buffing Wheel

U. S. Patent 2,508,072. *J. C. Miller.*

A buffing wheel comprising a plurality of circular sections clamped upon an arbor, each of said sections being made of a plurality of segments of relatively soft folded fabric fastened together near the center of the section and a disk of relatively stiff fabric impregnated with a drying oil located between each pair of sections.

Buffing Wheel

U. S. Patent 2,508,073. *J. C. Miller.*

A buffing wheel comprising a plurality of flat disks of fabric located side by side some of said disks being impregnated with a drying oil and others of said disks being untreated, said untreated disks being interspersed between said impregnated disks, all of said disks being fastened together near their centers, their peripheral portions being unconnected.

Gaseous Plating Inside of Gun Barrels

U. S. Patent 2,508,509. *L. H. Germer and G. E. Reitter, assignors to Bell Telephone Laboratories, Inc.*

Apparatus for supplying gaseous metallic carbonyls to the interior of a gun barrel or similar hollow object which comprises a nozzle mountable within the object together with means for moving the nozzle along the bore of the object, means for simultaneously maintaining a high degree of vacuum within the bore of the object, and means for heating the object to a carbonyl decomposing temperature simultaneously with the execution of the moving operation and the continued maintenance of the vacuum and supply of the metallic carbonyl.

Tin-Plated Aluminum Wire

U. S. Patent 2,509,117. *E. H. Wallace, assignor to U. S. Rubber Co.*

The method of forming a tinned aluminum conductor wire of composite laminae in which adjacent layers of deposited metals are securely bonded together comprising the steps, cleaning the aluminum wire with a solution containing a small amount of chromic oxide and sulphuric acid, then immersing the wire in a solution of an alkali metal carbonate and a chromate to provide an oxide coat on the alumi-

num, then treating the wire with nitric acid to etch the oxide coat, then electrodepositing a layer of iron on the etched surface, and finally applying over the iron a protecting coating of tin.

Chromate Treatment for Magnesium-Zirconium Alloys

U. S. Patent 2,509,273. *S. E. Mayer and W. F. Higgins, assignors to Magnesium Elektron Limited.*

A method of treating magnesium base alloys containing zirconium to afford protection against corrosion, wherein the metal is reacted upon and a surface film is formed, which comprises immersing said metal in an aqueous solution which consists essentially of water as solvent and the following solutes: viz., at least one substance selected from the group consisting of the dichromates of potassium and sodium in the proportions of 50 to 150 grams to one litre of water, and magnesium sulphate and manganous sulphate, each in the proportion of 30 to 70 grams of $MgSO_4 \cdot 7H_2O$ and $MnSO_4 \cdot 4H_2O$ respectively per litre of water, the solution having a pH value between 3 and 6.

Continuous Plating of Strip Metals

U. S. Patent 2,509,304. *C. J. Klein, assignor to National Steel Corp.*

Apparatus for progressively electroplating a continuously moving strip, comprising a plurality of pans across which the strip is passed successively in contact with electrolyte in the pans, said pans being spaced from each other horizontally and disposed side by side at progressively different elevations, each pan being adapted to contain electrolyte and having therein an electroplating anode, means for connecting the anode to a source of electroplating current, conduits directly connecting each pair of adjacent pans whereby electrolyte flows by gravity from one pan to the adjacent next lower pan, and strip guiding means in the spaces between adjacent pans for deflecting the strip downwardly as it passes from one pan to the next, said strip guiding means maintaining the strip horizontal in its passage through said pans and at a predetermined distance from the anode in each pan.

Purifying Zinc Solutions

U. S. Patents 2,509,916, 2,509,917, 2,509,918. *D. L. Griffith and M. J. Rankin, assignors to Hudson Bay Mining and Smelting Co.*

1. A method of removing impurities from zinc electrolyte solutions, comprising adding to the electrolyte small amounts of zinc dust, copper sulphate, a soluble arsenic compound, and thallium sulphate.

2. A method of removing impurities from zinc electrolyte solutions comprising adding to the electrolyte small amounts of zinc dust, copper sulphate, a soluble arsenic compound and from about 25 to 100 milligrams per litre of lead in the form of a soluble compound.

3. A method of removing impurities from zinc electrolyte solutions comprising adding to the electrolyte small amounts of zinc dust, copper sulphate, a soluble arsenic compound and from about 100 to 500 miligrams per litre of silver in the form of a soluble compound.

Zirconium Plating

U. S. Patent 2,510,128. *R. S. Miner, Jr. and L. E. Klekamp, Jr., assignors to Tung-Sol Lamp Works, Inc.*

The method of plating metals with zirconium comprising the electrodeposition upon the cathode, of zirconium reduced by electrolysis in a non-aqueous solution of an aliphatic alcohol and an electrolytically reducible chloride of zirconium.

Plating Rack

U. S. Patent 2,511,128. *A. G. Russell, assignor to Western Electric Co., Inc.*

A plating rack comprising an electrically conducting tubular member having a flat wall and a pair of spaced walls extending transversely from said flat wall, each of said spaced walls being provided with a plurality of apertures arranged in a row and disposed adjacent said flat wall and in transversely aligned relation to the apertures in the other one of said spaced walls for receiving and positioning a plurality of articles to be plated in a predetermined spaced relation to said flat wall, an elongated straight leaf spring curved in transverse cross section longitudinally mounted within said tubular member with its longitudinal edges engaging said flat wall and with the curved portion of the spring extending from said wall into the space between the aligned apertures in said spaced walls, said spring being at any point longitudinally thereof independently compressible against said flat wall and adapted to engage and yieldingly clamp against said tubular member articles inserted into said member through said apertures, means on said tubular member for connecting said member to a source of plating current, and means connected with said tubular member for retaining the spring therein.

Tin Alloy Plating

U. S. Patent 2,511,395. *S. W. Baier and D. J. Macnaughtan, assignors to The City Auto Stamping Co.*

The process of electrodepositing an alloy of the class consisting of copper, cadmium, zinc composed essentially of tin and an alloying metal and antimony, from an aqueous electrolyte consisting essentially of 10 to 100 grams per liter of a soluble tin compound in stannate form and 2 to 20 grams per liter of a cyanide-soluble compound of said alloying metal, using a soluble tin anode, a separate soluble anode of said alloying metal, and a cathode upon which the alloy is deposited, comprising forming on the surface of said tin anode an electroconductive surface film and maintaining at all times when said tin anode is in contact with said electrolyte a substantially uninterrupted flow of current, the current density at the tin anode being from 10 to 40 amperes per square foot during the electrodeposition of said alloy, the current density of said anode of alloying metal being from 10 to 25 amperes per square foot and the cathode current density being 20 to 100 amperes per square foot.

Silvering Non-Conductors

U. S. Patent 2,511,472. *G. J. Kmecik.*

The method of applying a metallic silver coating to an article of non-conducting material which includes the step of subjecting the surface of the article to the action of a solution of silver perchlorate in an evaporable organic solvent, permitting the evoporation of the solvent from the surface, and applying an alkaline reducing agent to reduce the silver salt on the surface to metallic silver.

Indium Plating

Indium is a soft, white tarnish-resistant metal which is widely used as a thin deposit on a variety of non-ferrous base metals either as a decorative finish or as a wear and corrosion resistant deposit. For maximum properties, the plated coating is diffused into the base by a two hour heat treatment at 350°F. Although indium may be deposited from a variety of electrolytes, best results on a commercial scale have been achieved with the cyanide and sulfate baths.

TYPE OF BATH	CYANIDE	HIGH pH CYANIDE	SULPHATE	FLUOBORATE	SULPHAMATE
BATH FORMULA	Indium (as Chloride) 4 oz./gal. Dextrose 2 av. oz./gal. Sodium Cyanide 12 av. oz./gal.	Indium 15- 30 g./L. KCN 140-160 " KOH 30- 40 " Dextrose 20- 30 "	Indium (as Sulphate) 2.4 tr. oz./gal. Sodium Sulphate 1.3 av. oz./gal.	Indium Fluoborate 31.5 oz./gal. Boric Acid 2.9-4.0 oz./gal. Ammonium Fluoborate 5.3-6.7 oz./gal.	Indium (Chloride) 75 g. HSO_3NH_2 852 g. NaOH 310 g. Triethanol Amine 8 C.C. Dextrose 30 g. (To make 1 gallon of solution)
pH		11	2.0-2.7	1.0	1.0-3.0
TEMPERATURE	Room	Room	Room	70-90°F.	Room
CURRENT DENSITY	10-100 A/ft.²	15-30 A/ft.²	20 A/ft.²	50-100 A/ft.²	20 A/ft.²
CATHODE EFFICIENCY	40-50%	75%	70-80%	75%	90%+
ANODE	Insoluble	Insoluble	Indium + Insol.	Indium + Insol.	Indium
TANKS	Glass, Rubber Lined or Steel		Acid Resistant Materials		
THROWING POWER	Excellent	Excellent	Poor	Good	Excellent
QUALITY OF PLATE	Excellent	Excellent	Fair	Good	Excellent

Polyethylene Linings for Anti-Corrosion

Polykote, Inc., Dept. MF, 446 Genesee St., Buffalo 4, N. Y.

Polyethylene linings for chemical and plating processing equipment offer outstanding resistance to highly corrosive materials that quickly corrode and destroy other metals and linings. One of the problems with polyethylene has been the difficulty in obtaining good adhesion to metal, but this has now been overcome by a flame spraying process that can deposit any required thickness with assured adhesion over a wide temperature range. The polyethylene film is tough, dense, and will resist concentrated acids and alkalis, as well as a wide range of food products and organic solvents.

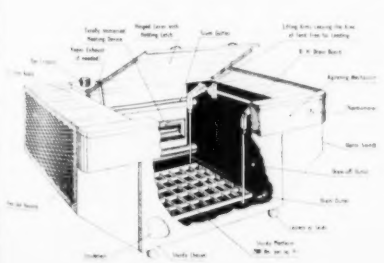
The above firm offers a coating service that can be performed either in their plant or in the plant of the customer.

Agitating-Dipping Cleaning Machine

Magnus Chem. Co., Dept. MF, Garwood, N. J.

The removal of metal chips from the mass of parts is not easy or anywhere near complete when spray cleaning machines or degreasers are used, according to this firm. In spray machines, the streams of cleaning solution are unable to penetrate into the mass of parts to remove the chips. In degreasers, cutting oils and the like are removed but the chips remain.

In the Magnus Aja-Dip Chip Removing machine the batches of parts are vigorously agitated up and down through the cleaning solution 54 times a minute. At each up and down stroke the solution is put in turbulent motion, swishing through the parts at each change of the stroke. As the solution rushes back and forth against and through the parts, it scrubs the parts and removes metal chips, oil and dirt even down in the center of the load, it is claimed. The chip removing job is fully automatic, requiring only manual loading and unloading of the machine—a one-man operation.



Magnus Chip Removing Machines are available in several sizes, handling from 75 to 10,000 pounds of parts per batch. Hot or cold cleaning solutions can be used.

For full details write to the Equipment Div. of Magnus Chemical Company at the above address.

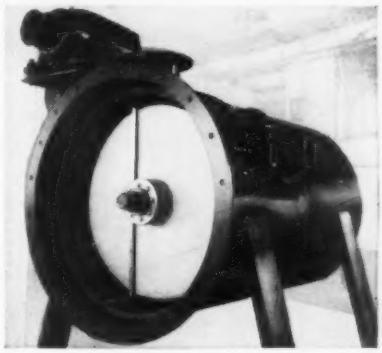
Self-Cleaning Filter

Sparkler Mfg. Co., Dept. MF, Mundelein, Ill.

A new industrial filter, possessing the important advantage of being self-cleaning, has recently been introduced by the above firm. Designated the Model SC series, the filter is designed for any filtering process where large amounts of solids are involved and where it is difficult or inconvenient to open the filter for cleaning. It is especially adaptable, also, for use with any solution where water can be used to flush out the filter aid.

A simple, mechanical arrangement is said to assure positive cleaning action whenever desired. This arrangement consists of having nylon brushes set between the unit's circular filter discs. Ends of the brushes are connected to a revolving brush cage that extends the length of the filter.

When the filter requires cleaning, water is flushed through the filter to the outlet drain, while this cage is revolved either by hand or motor powered means. Thus, the brushes, which are in contact with the discs on either side, sweep these surfaces clean. All matter that has accumulated on the discs drops to the bottom of the filter and is quickly washed through the outlet drain. In many applications, complete cleaning has been accomplished in only 2 to 5 minutes, according to the firm. Sparkler also points out that



Self-cleaning filter made by Sparkler Mfg. Co., shown with cover removed.

it is possible to use a backwash operation in conjunction with the brushes when clean backwash water or other liquid is available. Since the brushes do the bulk of the work, very little backwash water is actually required, thereby keeping costs to a minimum, it is claimed.

Construction of the filtering unit itself consists of a series of circular discs mounted on a hollow center shaft and enclosed in a horizontal cylindrical pressure tank. Each disc is perforated on both sides and is covered by a synthetic cloth which is sealed around the edge. Spacer rings between discs hold the cloth in place. The depth of this ring may be varied in accordance with the thickness of cake desired on the disc.

Arrangement and construction of the discs is such that when using filter aid in the filter, only a very short time is required for precoating, since a rather dense, woven nylon cloth can be used if desired. Also, fullest utilization of the filter's volume is provided, resulting in unusually high flow rates, according to the firm.

The Model SC series is available in a wide range of capacities, and can be made of corrosion resistant materials throughout.

Hydraulic Surface Polishing Machine

Clair Manufacturing Co., Dept. MF, 1009 South Union St., Olean, N. Y.

A special purpose, single spindle surface finishing machine has been announced by this firm. Developed in

scientifically compounded *for your*

DOUBLE AND SINGLE ROLL CUTLERY GLAZING MACHINES

Brushing NUGLU*

IT'S ☆

FAST DRYING!
BRUSHING OR SPRAYING!
USED IN ALL TEMPERATURES!
WITH GRAIN SIZES 46 TO 600!*

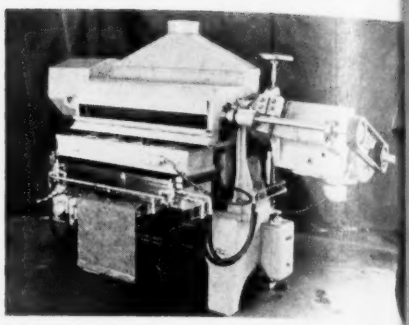
The grain is covered thereby eliminating harsh cuts. Cutting qualities continue for the life of the wheel, and by actual tests in factories *INCREASED* the *PRODUCTION 400%* on wheel set-up . . . MUCH BETTER FINISHES WERE OBTAINED!

*ALUMINUM OXIDE AND NUGLU MIXTURE

J.J. SIEFEN CO.

5641 LAUDERDALE • DETROIT 9, MICH.

Nationwide polishing and buffing service



conjunction with hand tool manufacturers, this Model 206 Machine can be equipped for either mechanical or magnetic holding.

Particularly recommended for applications where requirements approach a precision grind operation, it is claimed to be suitable for a wide variety of small metal products, including such things as pliers, wrenches, flatiron sole plates, pocket knife springs, axes, and hinges.

Actuated by an electro-hydraulic system, this surface finishing machine uses a single spindle, upon which a roll 40" wide may be mounted. Automatic hydraulic "in" and "out" stroke is adjustable from 0" to 24", with a maximum holding and working area of 24" x 38". An air circuit provides float of buff at any predetermined uniform pressure. This improved machine is claimed to be a close approach to a precision grinder as well as an extremely versatile contour finisher.

Pressure-Cooled Buff

United Buff Products Corp., Dept. MF, 233-241 Oak St., Passaic, N. J.

A patented, pressure-cooled buffing wheel, the Airflow buff, has been developed and is being manufactured for the metal and plastic industries by this firm. The buff, of unit-type, metal-center design, does not require any additional inserts, fillers, spacers, etc., it is claimed.

The buffing wheels are made in various cloths for many applications and, it is claimed, will surpass in economy, production, and quality any muslin buffs now in use. When used on plastics, burning, distortion, flowing and warpage are eliminated, it is claimed. It is also claimed that the Airflow buff will not ravel, can be run at higher speeds than heretofore possible without burning, and will retain liquid or bar compounds effectively.

Originally developed for the automotive industry, the buff is said to be widely acclaimed by the lamp, silver,

metal-finishing, aluminumware, cutlery, plumbing supply manufacture, hard rubber, and plastics fields. It is now being sold as far West as Arkansas, but sales distribution will soon be set up to the West Coast.

Tin Anodes

Division Lead Co., Dept. MF, 828 W. Kinzie St., Chicago 22, Ill.

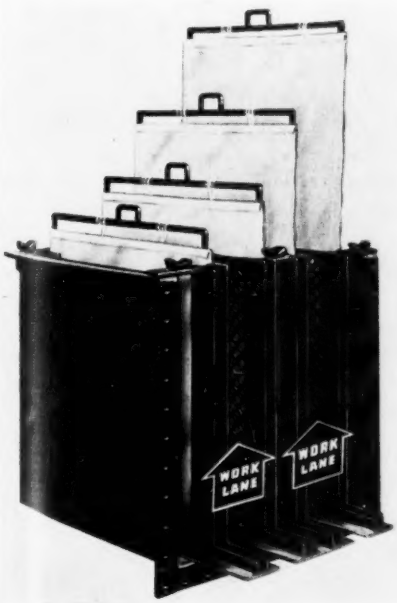
This firm announces that it has available for immediate delivery large stocks of tin anodes and tin chemicals for high speed plating of tin from alkaline stannate baths. Both the sodium and potassium chemicals are available. The anodes feature the patented Divco 29 point design for better throwing power. The firm claims that no royalty payments are necessary to use this tin plating process, and that the substitution of tin plating for cadmium plating in many applications, especially those where soldering connections are made, will result in a metal saving (tin is cheaper than cadmium), as well as having other advantages. Operating instructions for the process are also available by writing to the above address.

Converts Standard Tanks for Diaphragm Plating

Automotive Rubber Co., Dept. MF, 8601 Epworth Blvd., Detroit 4, Mich.

The possibility of converting existing plating tanks to the new diaphragm-type operation has been investigated thoroughly by the above firm, working in conjunction with some of the country's leading plating engineers.

As one of the leading manufacturers



For Any Plating Solution
Any Quantity

use an INDUSTRIAL Filter

100 to 15,000 gallons per hour. Portable and stationary models. Standard or special filtration systems engineered to meet unusual requirements.

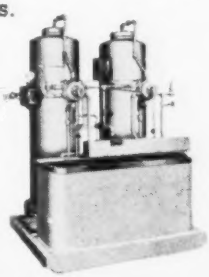
You save many ways . . .

Here's how Industrial filters keep down the cost of plating jobs—The flow rates of Industrial filters are based on the actual plating solutions involved. You know the capacity you get. In the filtration of plating solutions there is more than just the filter. With Industrial you get an adequate filter with slurry tank, motor driven pump, valves and fittings in a complete package with one, undivided, experienced responsibility—with space requirements at a minimum.

The labor, down time, and the inconveniences of cleaning, replacing the filter media, and reassembling the filter for every new filter cycle—all are eliminated by the Industrial Air-Wash Cleaning Method available for all models. It is necessary to remove the cover only when new filter cloths are installed. With Industrial filters, a clarified plating solution is always assured.

The engineering, design, and construction of Industrial filters have proved out in long service and low maintenance costs. Industrial has the experience and is large enough to handle your filter requirements. Since 1927 filters and filtration systems have been an important part of our business.

INDUSTRIAL Water Demineralizers



A Two-Bed INDUSTRIAL Water Demineralizer. Standard two-and four-bed units available with capacities of 200 to 1000 gph. Special units of any capacity engineered to requirements.

for **No stains after hot rinse. No unwanted precipitates in solutions.**

Write for full information and recommendations

FILTERS Pressure Type · PUMPS Centrifugal · CORROSION TESTING APPARATUS Salt Fog • Humidity

INDUSTRIAL FILTER & PUMP MFG. CO.

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Chicago 50, Illinois

RUBBER DIVISION Vulcanized Linings • Molded Products · WATER DEMINERALIZERS

Your Best Buy!

BUCKINGHAM
Greaseless
COMPOSITION

Fine
Medium
Coarse

Write Dept. A
for Samples

REPRESENTATION FROM COAST TO COAST

The BUCKINGHAM PRODUCTS Co.
14100 FULLERTON AVE. • DETROIT 27, MICH.

of special diaphragm equipment, the company has designed a conversion unit which can be installed in tanks where the size of the work permits, without major expenditure.

Diaphragm plating provides for the segregation of anode and cathode compartments by means of canvas duck screens.

The object is to produce smoother plated surfaces, allow higher current densities and eliminate polarization. The anode solution is pumped off, filtered and passed to the cathode compartment free of insoluble metallics and organics which form at the anode and ordinarilly deposit on the work pieces.

The conversion unit consists of fabric sleeves that slide on rubber insulated metal frames which in turn slide into insulated channels with the cathode side or work lane protected by insulated woven wire guards.

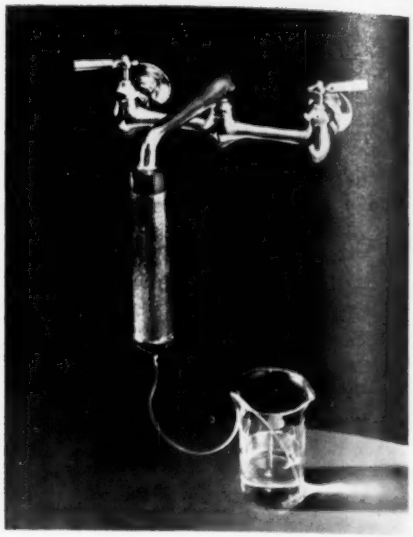
Diaphragm converter sections can be constructed for tanks of any width, length or department with single or multiple work lanes.

A catalog sheet has been prepared which more thoroughly describes the installation.

Miniature Ion Exchange Unit

LaMotte Chemical Products Co., Dept. MF, Towson, Md.

A new and refillable ion exchange unit delivers, from an ordinary faucet, water that is said to be equal in chemical quality to triple-distilled water. Called the Filtr-Ion, it is the smallest and lowest-cost application of the Monobed ion exchange principle.



It was designed for small-quantity uses where more elaborate equipment would be impractical. It provides water of extremely high quality for storage batteries.

The Filtr-Ion is essentially a transparent plastic tube, filled with Amberlite ion exchange resins, which is merely slipped over the end of a cold water faucet. Small holes in the top cap prevent excessive flow through the bed of resins. De-ionized water is delivered through a small plastic tube. The unit is not intended to remove bacteria or impurities which are not ionized, the manufacturer asserts. As water passes through the apparatus, however, metallic and other ionic solids are taken out of solution by the mixture of anion and cation exchangers. Fiberglas filters trap physical impurities.

These Amberlites change color when they become exhausted. Initially blue-black, the bed of resin turns light yellow in a gradually descending line as exhaustion progresses. When the yellow band reaches the bottom, the unit is refilled. Refill packages contain sufficient resins for two complete refills, and include new filter elements as well.

Quantity of deionized water delivered will vary with the hardness or mineral content of the raw water. Normally, up to 10 gallons of laboratory quality water may be expected from each unit.

Uniform Etching of Aluminum

The Diversey Corp., Dept. MF, 1820 Roscoe St., Chicago 13, Ill.

The Metal Industries Dept. of the

above firm has introduced a brand new product — an entirely different type of alkaline etching compound for all aluminum alloys.

Aluminux is the new product's name. Its use is claimed to eliminate cement-like scale and sludge from tank and coils, and to guarantee uniform, high-quality etch at lower cost.

Addition Agent for Clean Rinsing

Enley Products, Inc., Dept. MF, 254 Pearl St., N. Y. 7, N. Y.

This firm, makers of removable polyethylene linings for drums and crocks, announce a new product, Rinse-Clean.

Rinse-Clean applies a new principle of inactivating, in the final hot water rinse, salts which might precipitate or dry on finished work.

It is claimed to speed up drying, and to help prevent tarnishing. Recoloring is eliminated, and drying materials saved, according to the firm.

Rinse-Clean is highly concentrated, and only minute quantities are required as an addition to the final hot water rinse. Method of use is simple. Plated or acid-dipped work is merely dipped and removed.

Lightweight Plastic Jug for Hydrofluoric Acid

General Chemical Div., Allied Chemical & Dye Corp., Dept. MF, 40 Rector Street, New York 6, N. Y.

The first use of plastics in packaging Hydrofluoric Acid for industrial use has been announced by the above firm.

This new development is a molded polyethylene jug used to ship 10 pounds of B&A Technical Grade Hydrofluoric Acid and other liquid chemicals in small industrial lots. The package weighs only two pounds and is said to overcome the difficulties experienced with the heavy 17 pound lead containers previously used.

Baker & Adamson reports that the plastic jug provides a shatter-proof, tough, translucent, acid-resistant package that will not develop dangerous leaks common to the lead containers. Being exceptionally light, the jug is easy to handle. In addition to its utility, the jug enables the buyer to save freight on 15 pounds tare weight for each 10 pounds of acid purchased.

It is sealed with a screw-type polyethylene cap, and the special design of the neck and lip insures clean, accurate pouring.

General Chemical has been a major producer of Hydrofluoric Acid since the turn of the century.

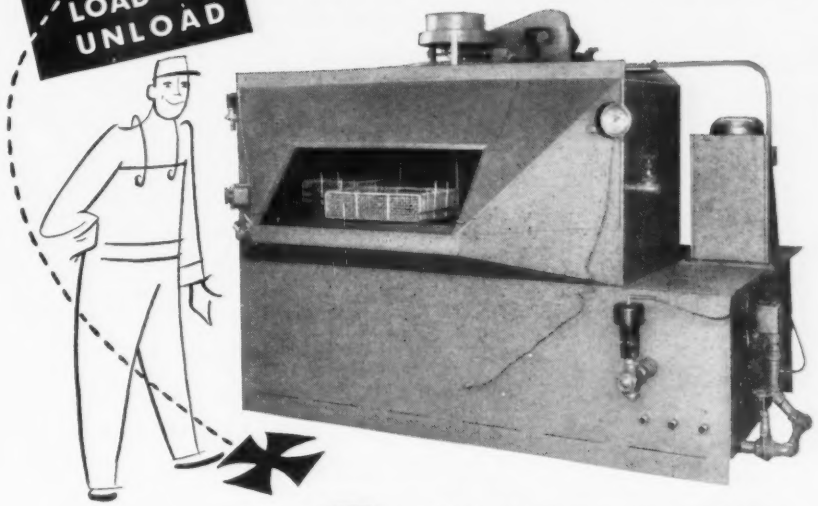
Reconditioning Service for Work Gloves

U. S. Industrial Glove Corp., Dept. MF, 9350 Roselawn Ave., Detroit 4, Mich.

A new work glove reconditioning service that is said to be saving one large user over 80% of all gloves sent

ONE MAN OPERATION with BLAKESLEE METAL PARTS WASHERS

ONE SPOT LOAD and UNLOAD



BLAKESLEE SOLVENT VAPOR DEGREASERS
—economical, efficient—
USE LESS SOLVENT

BLACOSOLV
Stabilized Degreasing Solvent — one price, one solvent *for all metals*

Blakeslee's new washer saves labor, is economical

Just one man can keep the production line going with this time saving metal parts washer. Turn table operation permits loading and unloading in one easy pivot movement. One revolution of the washer turn table and parts come out sparkling clean for a better finishing job with fewer rejects. Blakeslee washers are designed for every type and size of plant operation. Write for the cooperative services of our engineer-trained sales representatives.

G. S. BLAKESLEE & CO.
1844 S. 52nd Avenue • Chicago 50, Illinois
New York, N. Y. Toronto, Ont.

Is your production threatened by the impending shortage of chlorinated solvents necessary for your degreasers?

If your answer is "Yes," it will pay you to investigate the Magnus Emulso-Dip Process. For certain pre-cleaning operations, it offers definite advantages over solvent degreasing.

The facilities of the Magnus Laboratory are available to you without any obligation on your part. Send us a brief description of your operation. We can very quickly determine the extent of the help that the Magnus Emulso-Dip Process can bring to you.

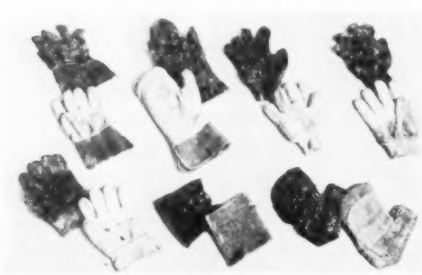
If the situation is urgent with you—a phone call to Garwood (Westfield 2-2500) will get you complete information on the Emulso-Dip Process.

MAGNUS CHEMICAL CO. • 11 South Ave., Garwood, N. J.
In Canada — Magnus Chemicals, Ltd., Montreal.
Service representatives in principal cities.

Magnus
CLEANERS • EQUIPMENT • METHODS

in for salvage is now offered on a national basis by the above firm.

Although new to the extent that it has not been offered nationally, the plan has been thoroughly tested for workability and is already proving successful in automotive, glass, welding, rubber, office machine and electrical plants, it is claimed. In many instances it has been found that workers prefer reconditioned gloves to new gloves because of pliability and comfort.



The service includes complete renovation, sanitizing and packaging of all types of worn-out fabric and leather gloves and protective clothing.

It is claimed that most gloves which were thrown away can be re-used. With the cost of new gloves already increasing approximately 15%, and more, and reconditioning costing only a fraction of new glove cost, a material savings can be effected.

Under the plan, U. S. Industrial Glove Corp. offers convenient transportation, at no additional expense, in all industrial areas. Fireproof containers are furnished, if desired.

A free trial plan is available which will be explained to firms interested in testing the service.

Tilter for Stainless Steel Barrels

General Scientific Equip. Co., Dept. MF, 2700 W. Huntingdon St., Philadelphia 32, Pa.

The new GS Safety tilter with pouring spout provides a safe, fast and convenient method of draining acids and other liquids from stainless steel barrels. The cradle and supporting base are made of structural steel. All members are riveted or welded to insure a strong, durable unit.

The locking device permits the tilter to be positively held at any angle for pouring so that the whole operation can be done by one man.

The new safety air vent pouring spout insures an even flow of liquid without spurts or splashes. This is made of acid resistant rubber and plastic tubing for long wear.

Flow capacity is 5 gallons per minute. The long handle operates the tilter easily and permits the operator to remain at a safe distance from the liquid.

Business Items

Pennsalt Appoints A. H. Clem Assistant to Vice-Pres.

Albert H. Clem has been appointed to the newly created position of assistant to the vice president in charge of sales of the *Pennsylvania Salt Mfg. Co.*, it was announced recently by *William P. Drake*, vice-president.

Mr. Clem was formerly assistant

Albert H. Clem

manager of sales in Pennsalt's Special Chemicals Dept. In his new position he will handle special assignments for the vice-president.

A graduate of Penn State, he joined Pennsalt in 1938 in the Research and Development Div. He later transferred to the Special Chemicals Dept. as sales service representative in the Detroit area and was subsequently product supervisor of Pennsalt cleaners before becoming assistant manager of the department. During the war he served as a lieutenant in the naval air force.

Mr. Drake also announced that *Horace F. McIntyre*, formerly Philadelphia district sales manager for the Special Chemicals Dept., has been appointed product supervisor in that department. *John M. Davidson*, formerly a sales service representative in the Pittsburgh district, became Philadelphia district sales manager. Mr. McIntyre joined Pennsalt in 1943 as a Special Chemicals sales service representative in the New York district. He became Philadelphia district manager in 1949. Mr. Davidson joined Pennsalt in 1946 following service as a commander in the naval air force and has been with the Pittsburgh office until his transfer to Philadelphia.

Du Pont Sells Chromic Acid Business to Diamond Alkali

Diamond Alkali Co. has announced the purchase of the chromic acid business of the *E. I. du Pont de Nemours and Co.*, Wilmington, Del.

The product will continue to be manufactured by du Pont at its Philadelphia plant, and under the terms of the sale, Diamond will take over distribution of the product on January 1, 1951. Amount of the consideration was not revealed.

Industrial Filter & Pump Appoints New York Sales Representative

The Industrial Filter & Pump Mfg. Co., of Chicago 50, Ill., manufacturers of pressure leaf filters, ion-exchange equipment, and rubber-lined products, announces the appointment of *A. Tonkonogy*, 45 Clinton St., Newark 2, N. J., as metropolitan New York district sales representative. Mr. Tonkonogy will handle sales and service of the company's products to the process, chemical, power, and other industries in the greater New York, Long Island,

A. Tonkonogy

MUTUAL RESEARCH

LEADS WAY TO LOWER COST

CHROMIC ACID TREATMENTS

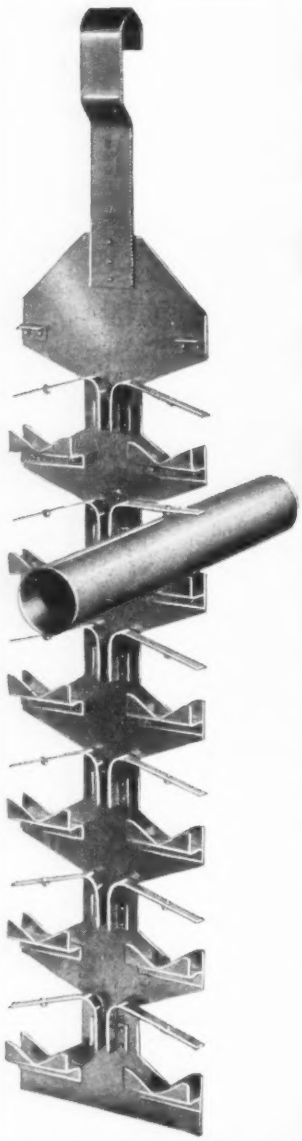
Possible cost savings in chromic acid anodizing, as well as in other metal treatments such as copper stripping, brass pickling, magnesium dips and chromium plating, are indicated through the use of oxidation-resistant cationic exchange resins. In a preliminary investigation by Mutual Chemical Company of America, certain commercial resins have been found to be stable in the presence of chromic acid. As a result, these resins may be used for removing dissolved metals from chromic acid solutions with the recovered chromic acid made available for re-use. An added advantage is in minimizing the problem of waste disposal.

Write today for a copy of "Regeneration of Chromic Acid Solutions by Cation Exchange" Mutual's Serial No. 65.

MUTUAL CHEMICAL CO. OF AMERICA — SINCE 1845

MUTUAL CHEMICAL CO. OF AMERICA

270 MADISON AVENUE • NEW YORK 16, N. Y.



PLASTISOL INSULATION

Racks • Fixtures

ELECTRO PLATING JIGS ANODIZING FIXTURES

NEW materials and manufacturing processes make BUNATOL No. 1002 the preferred insulation for racks and fixtures for use in electro plating, anodizing and hard Chrome. Low cost with exceptional long insulation life will keep down rack expense.

BUNATOL No. 1002 is a 100% solids plastisol with exceptional toughness for wear resistance, and chemical resistance to withstand all plating and anodizing solutions. The high gloss surface gives complete and fast rinsing without carry over. Important too is that a *single* Primer coat is used — which also saves time, labor and cost.

No. 1002 is also very effective as a coating for jigs and fixtures for assembling. The tough resilient coating stops scratching and marring of the work. Simple to apply and lasts indefinitely. Not affected by oils, grease and chemicals, and remains soft and springy.

Just a note on your letterhead will bring complete information and samples.

Nelson J. Quinn Co. — Toledo 7, Ohio

northern New Jersey, and southern New York state territory.

Allied Research Appoints Hoffman Director of Research

Allied Research Products, Inc., Baltimore, Md., has announced the appointment of *Mr. R. A. Hoffman* as Director of Research.

Mr. Hoffman joined Allied Research on February 1, 1950, having previously been associated with *E. I. du Pont de Nemours & Co., Inc.* as a research chemist, and president of The *R. A. Hoffman Chemical Co.*, Cleveland. Mr. Hoffman is a graduate of Ohio State University and later received a degree of Master of Chemistry from Western Reserve University.

Mr. R. A. Hoffman

As Director of Research, Mr. Hoffman will head up Allied exploratory activities in the development and perfection of new additions to the line of Iridite coatings for corrosion resistance and ARP plating chemicals.

Verstegen Added to H-VW-M Sales Staff

G. E. Verstegen

The *Hanson - Van Winkle - Munning Company*, Matawan, N. J., announces the appointment of *Gerhard E. Verstegen* to its staff of equipment sales engineers. Mr. Verstegen attended Universities of Buffalo and Michigan where he studied mechanical and hydraulic engineering. He has had wide experience in the design and engineering of hydraulic equipment, including die casting machinery, in various parts of the United States.

For H-VW-M, he will specialize on full and semi-automatic conveyors, with headquarters in the Chicago office of the Company.

Richardson-Allen Moves to New Quarters

Richardson-Allen Corp., manufacturers of selenium rectifiers for the conversion of A.C. to D.C. current, battery chargers, and various types of industrial controls have moved to their new office and factory at 116-15 Fifteenth Avenue, College Point, Long Island, N. Y.

C. E. Brigham, Vice-President, reports that after many years at the previous location, 15 West 20th St., N. Y. C., expanded facilities were needed to keep pace with the vigorous growth of the corporation in the selenium rectifier and battery charging field.

F. B. Stevens Adds E. C. Elliott to Their Sales Organization

Mr. Edwin C. Elliott, of Geneva, New York, has been added to the sales staff of the Plating and Polishing Div. of *Frederic B. Stevens, Inc.* of Detroit, to represent the company in New York State.

Mr. Elliott was formerly connected

E. C. Elliott

with the Geneva Forge, Inc. in the capacity of plating superintendent. He has had wide experience in both manual and full-automatic plating and polishing operations.

Previous to his association with Geneva Forge, Inc. he was plating superintendent for the Commercial Controls Corp.

Mr. Elliott will make his headquarters at 95 Highland Avenue, Geneva, N. Y., and will be available at all times for the discussion of plating and polishing problems with Stevens customers.

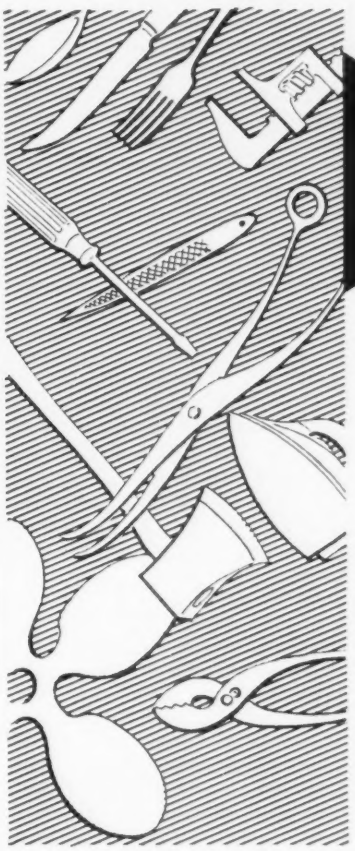
He succeeds *Mr. E. T. "Eddie" Homan*, one of the oldest active members of the A.E.S., a charter member of the Philadelphia Branch, and widely known throughout the industry. Up to the time of his retirement Mr. Homan had, for many years, covered the New Jersey, New York and part of the Pennsylvania territory for Stevens.

Powers New Chicago Manager for Diversey

B. W. Powers, formerly a field service representative in Indianapolis for the Maintenance Products Dept. of *The Diversey Corp.*, Chicago, has been named district manager for the Chicago area, with supervision over all

EXTREME *Versatility*

for Lower Finishing Costs



CLAIR

SURFACE FINISHING MACHINES

A versatile Clair Surface Finishing Machine may be the answer to economical, production-quality surface finishing of your products. Combining the "touch" of the old time craftsmen with extreme versatility and high speed production, Clair Surface Finishing Machines are soundly engineered and ruggedly built.

By cooperative counsel between your engineers and Clair designers, custom surface finishing equipment may be developed to give maximum efficiency and economy on your metal finishing operation.

May we show how Clair Surface Finishing Machines can save money for you? Write for technical data.

CLAIR MANUFACTURING CO., INC.

SPECIALIZED MACHINE EQUIPMENT FOR GLAZING AND POLISHING OPERATIONS

OLEAN, N. Y.

B. W. Powers

Maintenance Products Dept. sales representatives working out of the Central Division. Powers' promotion was announced by General Sales Manager *W. E. Noyes*.

Powers joined Diversey a little over a year ago. Upon completion of the sales training course for Maintenance Products Dept. representatives, he was assigned to the Indianapolis territory.

For four years of the last war, Powers served in the Marine Corps. After his service had been completed, he studied business administration at Franklin College, Franklin, Ind.

Du Pont Builds New Cyanide Production Plant

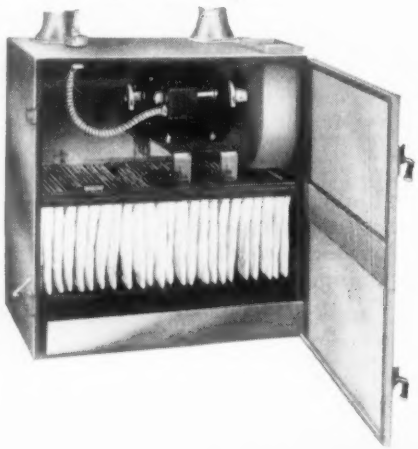
Plans for the construction of a chemical plant at Memphis, Tenn., at

HUSKY
and
FAST!

Long trouble-free service and ease of operation are the prime requisites for equipment of any kind.

HISEY Buffers - Polishers embody these features to such extent that they afford lowest cost per year with maximum production.

They are made from small bench types up to 30 H.P. Pedestal types. There is a size and type particularly suited to your requirements. Let us show you.



These new HISEY Dust Collectors fill a long felt need for efficient dust collecting at reasonable cost. They are made in four sizes which cover most applications and can be supplied with new machines or for machines already in service.

CATALOG 71FE FREE ON REQUEST

Hisey THE HISEY-WOLF MACHINE CO.
CINCINNATI 8, OHIO
Division of The Cincinnati Electrical Tool Co.

an estimated cost of $7,500,000, were announced recently by *E. I. du Pont de Nemours & Co.*

The new plant will be built about 10 miles north of the business district on a 225-acre site purchased last May and will be operated by the company's Electrochemicals Dept. *James J. McIntyre*, who will be manager of the new plant, already has reported to Memphis. He has been assistant manager of Du Pont's Niagara Falls, N. Y., plant.

The new plant will manufacture sodium cyanide, a basic chemical used widely in industry. It will employ about 180 persons when it starts operating. It is expected that construction will be started this winter and that it will take about a year to build the plant.

The new plant will be of the modern, open-air type of construction conforming to the latest advances in chemical process design. Most of the equipment will operate in the open with controls located in small buildings. Offices and service facilities will be in attractive buildings constructed of concrete, brick, and steel. The plant will have complete waste control equipment so that there will be neither water nor air pollution.

Norton Abrasives Appoints Van Keuren Chief Sales Engineer

Robert G. Van Keuren, has been appointed Chief Sales Engineer for the Abrasive Div. of *Norton Co.*, effective November 1. The announcement

R. G. Van Keuren

was made by *Ralph M. Johnson*, vice-president in charge of sales.

Mr. Van Keuren succeeds A. Oakleigh Bush, who died September 2.

Since 1945 Mr. Van Keuren has been a section head in the Sales Engineering Dept. with the title of Sales Engineer. He joined Norton Company in 1923 as a member of the Adjustment Section in the Worcester Sales Department. In 1929 he transferred to the Sales Engineering Department and has been there ever since.

Manhattan Rubber Announces Sales Promotions

Two sales promotions have been announced by *Raybestos-Manhattan, Inc., Manhattan Rubber Div., Passaic, N. J. John T. M. Frey* has been appointed assistant manager of the New York Branch, and *Lamar S. Hilton* is now assistant sales manager of the abrasive wheel department. Mr. Frey has been a member of Manhattan's New York sales organization for many years. Mr. Hilton formerly served in the capacity of sales engineer.

H-VW-M Transfers Mel Teets to Sales

W. M. ("Mel") Teets has been transferred from the laboratory staff to the sales force by the *Hanson-Van Winkle-Munning Co.*, Matawan, N. J., with headquarters in the company offices in New York.

Mel Teets' experiences have been varied. After graduation from High School in 1943, he entered the Army and was assigned to the United States Army Air Force. He was sent to England where he flew twenty-eight mis-

W. M. Teets

sions over Germany with the 306th Bombardment Group of the 8th Air Force. Upon returning to the States, he was an instructor for a short time in radio work at Sebring, Florida. In February, 1946, he entered Lafayette College from which he graduated in June, 1949 with a B.S. in Electrical Engineering.

After graduation, he was employed by the Hanson-Van Winkle-Munning Co., where he worked in their laboratory to gain a knowledge of plating and polishing prior to his present position as salesman in the Metropolitan area.

Binz Retires from Sarco; to Handle Advertising Account

Effective November 1, *Mr. Gus A. Binz*, for twenty years Sales Promotion Manager for the *Sarco Co.*, New York, retired from the firm. Mr. Binz has established himself as an independent advertising agent and will handle the Sarco Co.'s advertising account. He has opened his business office at 332 Springfield Ave., Summit, N. J.

Oakite Holds Annual Technical-Sales Meetings

How recent developments in the field of cleaning and allied procedures are helping industry meet the demands of increased production was the central theme of a series of technical-sales meetings held in New York, Cleveland, and Hollywood, Cal., during the month of November by *Oakite Products, Inc.*

As in former years, the meetings were in the nature of a general sales and technical review, embodying round-table discussions on new materials and servicing methods designed to save time and work on a wide range of industrial cleaning and associated tasks. The first of these conferences, held at the Hotel Statler, New York City, November 2-4, was attended by field service representatives of the Company's New York, New England, Southern and Canadian sales divisions. A feature of these meetings were special reports presented by Oakite research chemists, service engineers and technicians on latest trends in cleaning and related practices for nearly every branch of industry. Also discussed were new materials to be made available by the Company during the coming year.

Similar conferences held at the Hotel Statler, Cleveland, November 9-11, and the Roosevelt Hotel, Hollywood, November 16-18, were attended by Oakite technical service representatives from the Chicago, Cleveland, Detroit, Milwaukee and Philadelphia divisions, and the Pacific Coast, Midwestern and Southwestern sales territories respectively.

Electric Products Co. Appoints Missouri Agents

The *Electric Products Co.* of Cleveland, O., have appointed the *Power Equipment Co.* as their representatives in the western counties of Iowa and Missouri, the panhandle counties of Texas and the states of Arkansas, Oklahoma and Kansas.

With offices in Kansas City, the

Save up to 80% on Rack and Tank Replacement Costs

HYSOL 3000 Rack Coatings

Since they resist the corrosive action of all chemicals commonly encountered in plating operations, Hysol Coatings vastly reduce rack, tank and duct replacement costs. Offering far longer protection than conventional coatings, Hysol 3000 Coatings provide a smooth finished surface which holds solution drag-out losses to a minimum.

- Save up to ⅓ on electric current costs
- Resist all corrosive chemicals.
- Reduce solution losses.

Quickly and conveniently applied by your own personnel, these tough coatings resist chipping and abrasion damage. If damage does occur, it is easily repaired by Hysol Patching Compound.

In addition to supplying coatings, Houghton Laboratories is equipped to coat existing racks or to build and coat new racks and ducts to your specifications. *Write for prices, technical data and samples.*

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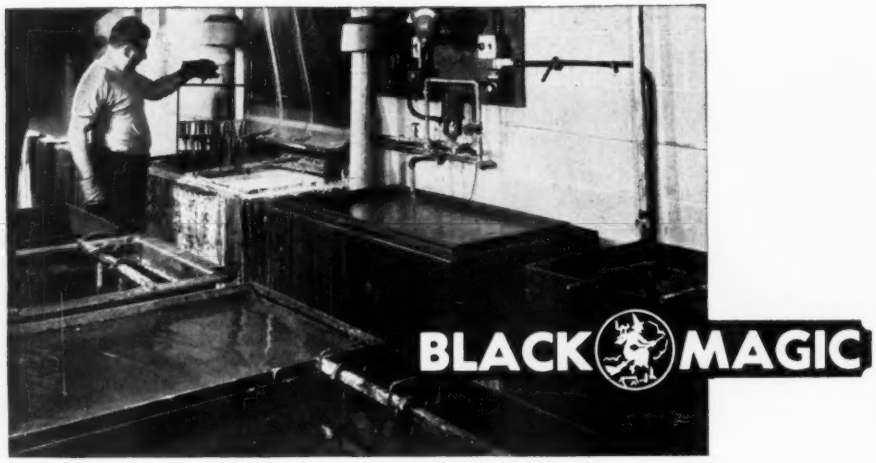
OLEAN, NEW YORK
Plants at: Olean, and Smethport, Pa.



Speed up your finishing operations with fast acting and economical

BLACK-MAGIC ONE BATH PROCESSES

FASTER PENETRATION due to higher oxidation potential and catalysis gives a fine, oxide black that will not rub off.

QUALITY . . . Laboratory control and highest quality chemical components insure uniformity.

TROUBLE FREE . . . Each installation engineered to needs of specific requirements and periodically supervised by competent chemical engineers.

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It contains the story of Black-Magic Finishes, also data on all other Mitchell-Bradford products. Free. Send today.

Cut time and costs by consulting us at once!

MITCHELL-BRADFORD CHEMICAL COMPANY
MODERN METAL FINISHES
2446C MAIN ST., STRATFORD, CONN.
BLACK-MAGIC OXIDE BLACKING SALTS
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SILCO *Glass-Base* PROTECTIVE COATING
HEAT TREATING SALTS. CLEANERS. ETC.

Power Equipment Co. will handle all the industrial lines of The Electric Products Co. They will be responsible for promoting The Electric Products Co. Synchronous and Induction Motors, A-C and D-C Motors and Generators, Battery Chargers, Electrolytic Power Supplies and Frequency Changers.

Diversey Makes Two Executive Changes

David F. Seymour, formerly in technical sales service for the Metal Industries Dept. of *The Diversey Corp.*, Chicago, has been transferred to the South Gate, Cal., plant of Diversey as plant manager and supervisor of manufacturing operations.

Seymour succeeds *Eric C. Foote, Jr.*, who moves to the new plant of The Diversey Corp. (Canada) Ltd., Port Credit, Ontario, as plant manager and supervisor of manufacturing. Announcement of promotions of the two men was made by Chairman *H. W. Kochs*.

David F. Seymour

Seymour joined Diversey in 1947. He received his degree in chemistry from the University of Minnesota. Following college, he gained valuable experience working with a number of large anodizing and plating companies. For two years before coming to Diversey he was with the *Promat Div.* of *Poor & Company* in plating research and service.

Foote also joined Diversey in 1947 after service in the Navy as a Lieutenant. He received his degree in chemical engineering from Northwestern Uni. Foote was an engineer in the Technical Development Dept. prior to his appointment early this year as plant manager and supervisor of manufacturing at South Gate.

Eric C. Foote, Jr.

Columbia Chemical to Produce Perchlorethylene

The *Columbia Chemical Div.* of *Pittsburgh Plate Glass Co.* has begun partial production of perchlorethelyne, an organic chlorinated solvent used widely for metal degreasing.

The Columbia Chemical Div., one of the nation's largest merchant producers of chlorine, is diversifying its manufacturing operations into products which utilize chlorine in their chemical composition. In addition to chlorine, major products of Columbia at Barberton are soda ash and caustic soda.

American Buff Co. Now Headed by a Kentucky Colonel

Mr. Ben P. Sax

Mr. Ben P. Sax, President of the *American Buff Co.*, of Chicago, was recently commissioned a Colonel of the State of Kentucky and an aide-de-camp on the staff of *Governor Earle C. Clements*. Mr. Sax now proudly displays the impressive document of his appointment in his Chicago office.

Pennsalt Moves Chicago Sales Office

Pennsylvania Salt Mfg. Co. recently announced the removal of their district sales office to *Suite 1216, Builders Building, 228 North LaSalle St., Chicago.*

The new office will be under the direction of *George D. Grogan*, District Sales Manager for the company's Heavy Chemicals Dept., and *John C. Hampson*, District Sales Manager for the Special Chemicals Dept.

Donald Sales Appointed Wisconsin Distributors for MacDermid, Inc.

MacDermid Incorporated, of Waterbury, Conn., recently announced the appointment of *Donald Sales and Mfg. Co.*, 6601 West State St., Milwaukee 13, Wisconsin as exclusive distributors in Wisconsin for their complete line of metal cleaners, bright copper, and other metal finishing preparations.

Donald Sales and Mfg. Co. will carry complete stocks of these materials in their Milwaukee warehouse.

Mr. T. F. O'Brien, MacDermid Sales Engineer, will be available for customer service concerning any metal finishing problems.

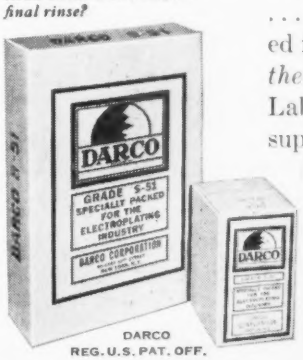
Start Clean... Stay Clean!

It's the rule of the sea - - and the plating industry!

Don't risk the time, labor, and expense that go into cleaning work for plating by putting clean work into a plating bath of questionable purity!

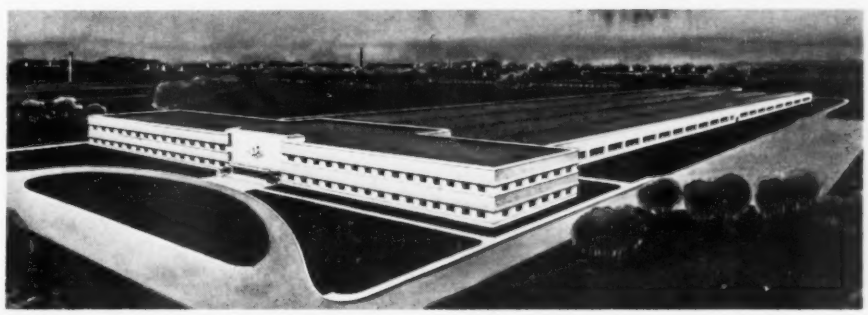
Start clean . . . *stay* clean—use Darco S-51 to trap trouble-making impurities! Darco adsorbs impurities to its surfaces before they can be deposited on the freshly cleaned surface of your work.

Is your plating bath as clean as the water in your final rinse?



Darco S-51 is especially easy to handle . . . to wet . . . to incorporate into a slurry. It's especially treated for use in plating—*the only carbon that will meet the benzol-mercury test!* Place an order for Red Label Darco S-51 today. Practically all leading suppliers carry Darco—don't accept substitutes!

DARCO DEPARTMENT
ATLAS POWDER COMPANY
Darco General Sales Offices
60 East 42nd Street, New York 17, N. Y.



Powers Regulator Co. Erecting New General Office and Factory Building

Scheduled for completion next summer, at the time of the company's 60th anniversary, is the new Powers' plant on its 13 acre site in Skokie, Ill.

The building, which will contain 130,000 square feet, is 575 feet long. The two story office, which is 290 feet wide, is to be constructed of face brick and stone and will be completely air conditioned.

Products to be manufactured in this new modern plant include the company's extensive line of automatic temperature and humidity controls for heating, air conditioning and industrial processes; thermostatic controls for water heaters.

Associations and Societies

AMERICAN ELECTROPLATERS' SOCIETY

Newark Branch Annual Christmas Party and Educational Session

The Newark Branch of The AES will hold their Annual Christmas Party and Banquet on Saturday, December 16th, at the Hotel Robert Treat, Newark, N. J.

The Educational Session will start at 2 P.M., with the following talks:

FILM PRESENTATION

Dr. W. A. Wesley — International Nickel Co. "Porosity and Its Effects in Electroplating."

Mr. H. E. Shearer — Keystone Lamp Mfg. Corp. "Production Brass Plating."

The Banquet will be held starting at 7 p.m. A floor show and dancing will be a part of the evening's festivities.

Baltimore-Washington Branch

The fall season of branch activities was opened with a plant tour of one of the largest electrolytic copper refineries in the world. During the afternoon of October 10 the Baltimore plant of the American Smelting and Refining Company was host to thirty-one branch members and guests. The trip followed the sequence of operations in converting blister copper (99% Cu) to refined metal of 99.99% purity.

On November 7 *Mr. Robert Tiers*, of the Whitemarsh Labs., Pennsylvania Salt Mfg. Co., gave an enlightening discussion entitled "Trouble Shooting in Alkaline Cleaners." Acknowledging that metal cleaning is still more art than science, the speaker stressed the need for establishing actual conditions existing when trouble is encountered, often resulting in bringing to light unusual and unaccounted for variations from standard procedure. Changes in type of surface soil to be removed, usually due to prior process modifications, are common causes of trouble because the metal cleaning department only rarely is kept advised so that cleaner formulations can be altered accordingly. The speaker deplored the lack of cleaner evaluation methods, especially any which might be suitable for plant control. The recently developed water spray and swirl techniques for soil removal were described, as was a timed cycle automatic device employed experimentally for measuring the useful life of cleaning solutions. Mr. Tiers pled for the development of standardized soil compositions, so that work carried on by different investigators might produce comparative data. Active discussion of the subject carried on into the informal thirst-quenching session which followed.

Responding to the request of the Supreme Society officers, *Mr. K. M. Huston* spoke briefly on the importance of maintaining high quality in plated ware production in spite of the current shortage of nickel. Reference was made to the outdoor exposure data on Cu-Ni-Cr finishes now being accumulated by ASTM, showing the danger of reducing nickel thickness without proper adjustment of copper thickness; direct substitution in equal

TRUE BRITE IS FIRST

TRUE BRITE NICKEL BRIGHTENER was the first nickel brightener definitely designed for barrel plating at higher speeds to match still tank bright nickel and provide for good chromium plating on racks or in barrels.

TRUE BRITE BRASS MAINTENANCE COMPOUND is the first complete brass plating compound designed to take away the headaches of off color deposits. Now available in various ratios for various brass and bronze colors.

TRUE INSULATORS are the first insulators for coils in plating tanks designed especially for the electroplating industry. Available in popular sizes for immediate delivery.

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Complete Service for Metal Finishing

Products Listed Below Available in New York Stock With Reasonable Exceptions

GENERATORS

Anodes, All Kinds
Brushes
Buffs
Chemicals
Tripoli Comp.
Acme White Finish
Tallow
Rouge
Emery Paste
Cleaners
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Glue
Nickel Salts
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Cyanide
Tanks, All Kinds
Plating Barrels
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FILTERS

MAIZO Drying Materials

LEA Buffing & Polishing PRODUCTS

thickness of copper for nickel may product undesirable results. For more specific information platers were referred to the personnel of Subcommittee II of ASTM Committee B-8.

Chicago Branch

At the November 10 meeting 81 members and guests were present to hear *Mr. William Jackson* talk on "Barrel Plating Equipment and Plant Layout." The speaker limited his discussion to materials of construction of equipment, and particularly its placement in the plating room for most efficient operation. Several flow charts were used to illustrate the talk and to bring out not only desirable cycles, but also point out mistakes that are commonly made in laying out equipment for barrel plating.

Librarian *Joe Andrus* announced that plans have been made for the educational part of the annual Chicago party. Present arrangements call for three speakers, each well known in his particular field, and the subject of the program will be the preparation of metal for electroplating.

Cincinnati Branch

The October meeting of the Cincinnati Branch was held on October 25th with 38 members and guests present. Following dinner and a short movie on sports, our speaker, *Mr. Paul O. Blackmore*, Director, Basic Development Lab., *Interchemical Corp.*, Newark, N. J., addressed the Branch on the subject "Adhesion Problems in Metal Painting."

By means of slides to supplement his discussion Mr. Blackmore discussed the two types of adhesion which act to keep a paint film on a metal or wood surface. He stressed the point that absolute cleanliness of the surface was essential for proper adhesion. He then described in detail the Interchemical Adherometer which was developed by that company for the measurement of adherence or adhesion. Following his talk there was a question and answer period which demonstrated the interest of the Branch members in the subject.

The subject was of sufficient interest to attract two Branch members from Richmond, Ind., approximately 60 miles from Cincinnati, as well as two Branch members from Maysville, approximately 50 miles from Cincinnati.

The usual Social Hour followed the educational part of the meeting. We

THERE IS NO SUBSTITUTE FOR *Experience*

The perfection of this product is the direct result of more than 25 years of experience gained in manufacturing many millions of pounds of polishing compounds and other quality-controlled abrasive materials for the production lines of the Automotive Industry and its many suppliers in the field of Metal Finishing. We sincerely believe it to be the best product for the purpose on the market today.
C. H. McALEER, President.

WE KNOW A TEST WILL PROVE

INCREASED PRODUCTION—Scientific "know-how" of the blending of abrasive grains and binders and proper selection of the compound suited for the job gives you the most uniform finish and increases speed of production.

ECONOMY IN USE—The improved and more durable binder gives ideal adhesion to the wheel; drying time and less "off the wheel" wastage.

IMPROVED CONTAINER—Our aluminum-foil container is almost impervious to moisture-loss and when properly stored will remain in good condition for a year.

LABORATORY CONTROL—Constant laboratory control of all raw materials used and experienced supervision of manufacturing processes is maintained at all times.

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COMING EVENTS OF THE A. E. S.

Newark Branch
Christmas Party and Educational Session
December 16
Hotel Robert Treat — Newark, N. J.

Chicago Branch
January 27, 1951
Annual Educational Session and Banquet
Stevens Hotel — Chicago, Ill.

New York Branch
February 17, 1951
Annual Educational Session and Banquet
Hotel Statler — New York, N. Y.

Los Angeles Branch
Annual Convention June 25-28
Biltmore Hotel — Los Angeles, Calif.

were very pleased to have with us as guest *Mr. Harvey J. Johnson*, of the *Belke Mfg. Co.*, Chicago.

Los Angeles Branch

Seventy-five members and guests of Los Angeles Branch of the AES turned out on the night of October 11th to hear *Charles M. Brown*, chief electrical engineer of the *Bone Engineering Co.*, Glendale, Calif. present a talk on "Electricity in the Plating Shop."

Mr. Brown, a graduate of the California Institute of Technology, offered a comprehensive discussion of vital principles of electricity as relating to the plating shop and various problems that arise in the shop in connection with the power used. He dealt in turn with such items as stray currents, bus bar current loss, electrical heating of plating solutions, and numerous other phases.

At the conclusion of the talk, Mr. Brown announced that he was prepared to answer questions. He did not know what he was letting himself in for. The members had been waiting for a long time for a genuine electrical engineer to pop questions at and they took full advantage of the opportunity to give the complicated subject of plating shop electrical installations a thorough going over. Mr. Brown proved to be an affable and competent answerer of the many questions fired at him.

An added feature of the educational program was a short talk by *Morrie Schwartz*, chairman of the educational committee, on "What is Anode Polarization?" This was one of the questions submitted during the September meeting question-and-Answer period.

Reports from various chairmen of national convention committees disclosed that the hotel, program and entertainment committees are making some concrete progress, even at this early date. A savory advance news note—there will be an old-fashioned out-doors typical "western" barbecue with all the trimmings.

Morrie Schwartz, chairman of a three-man committee which was appointed at the September meeting to recommend a man whom the branch could support for the post of national third vice-president at the 1951 convention, reported that two men are available who fullfill the qualifications as to character and competence for national office. These are *Marcus Rynkofs* of the Liberty Plating Co., Los Angeles, and *Richard Wooley*, branch president and Pacific Coast Manager of United Chromium, Inc. Ballotting to determine the candidate whom the branch will support at the convention will be held at the November meeting.

Harry Osborne was initiated into membership. The applications of the following were received: *Douglas Simpson*, Cal Nevar Company; *Phillip Simon*, Barber-Webb Co.; *Arthur Heath*, L. H. Butcher Co.; *Sol Berg*, Eagle Plating Co.; and *Allen F. Savage* and *Albert S. Ibanez* of All-American Mfg. Co.

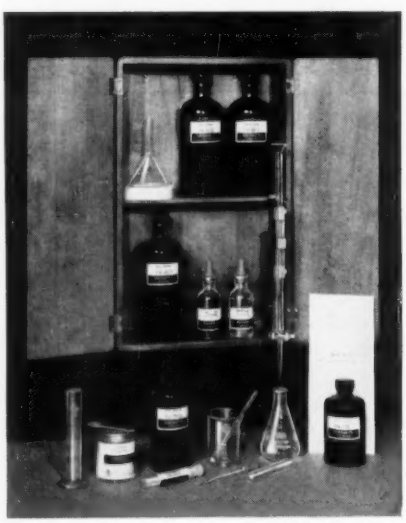
Chicago Branch

At the October meeting 130 members and guests were present to hear our past president *Frank Savage* give a most informative talk on "Auxiliary Equipment in the Plating Room." In addition to numerous items of auxiliary equipment, Frank also instructed those present on the use of automatic solution level control, automatic pH control, conductivity cells for returning boiler condensate, as well as other

TEST SETS FOR ALL PLATING NEEDS

EASY... No knowledge of chemistry required

QUICK... Direct reading



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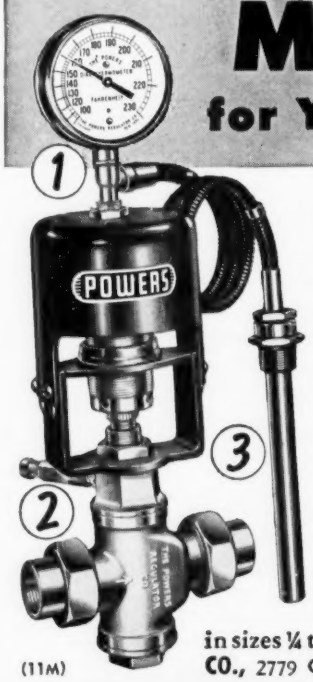

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2 Valve Stem Lubricator at no extra cost.

3 Over-Heat Protection at no extra cost.

Reduce Costs—with this better type of self-acting temperature regulator. It prevents OVER-heating. Controls liquids or air, heating or cooling. Valve Sizes ¼ to 2" incl. Available without thermometer in sizes ¼ to 6". THE POWERS REGULATOR CO., 2779 Greenview Ave., Chicago 14, Ill. Offices in 50 Cities

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POWERS No. 11

TEMPERATURE INDICATING REGULATOR

Simple • Dependable • Economical

items of equipment. A lively question period followed.

At this meeting the Chicago Branch was host to the Chicago Electroplaters Institute. The Platers Institute and the Chicago Branch have enjoyed a close association for some time, which has been of great benefit to both organizations.

Los Angeles Branch

Richard Wooley, of Los Angeles, Pacific Coast manager of *United Chromium, Inc.*, was unanimously selected at the November 8 meeting of The Branch as the man they would support as a candidate for 3rd vice-president of the Supreme Society at the 1951 convention.

The names of Wooley and *Marcus Rynkofs* had been submitted. Mr. Rynkofs however announced that he was compelled to withdraw because the press of business at his firm would make it impossible for him to devote sufficient time to the post, if elected.

Eight applicants were approved for membership in the branch. These included *Elmer Sanders*, of Price-Pfister Co.; *Allen F. Savage*, All-American Mfg. Co.; *Arthur N. Heath*, L. H. Butcher Co.; *Sol Berg*, Eagle Plating Co.; *Raymond Steele* and *T. A. Kuttu*, Tool & Jig Plating Co.; *Keith Holtzclaw*, Industrial Electronics & Transformer Co.; and Douglas Simpson.

The speaker of the evening was *Clarence H. Sample*, of International Nickel Corp., New York, who told the branch something about the gravity of the nickel situation.

Sample explained that in June it became apparent that the demand for nickel would exceed the supply; the firm began rationing in July. Shortly thereafter, with the aggravation of the Korean situation into an actual shooting war, the nickel problem became even more acute as the needs for stockpiling and the defense program came into the picture.

"The situation is serious," he said. "As far as we can see, it will be tough for some time to come, as defense requirements for nickel are great and stockpiling demands are firm."

The second phase of Mr. Sample's presentation at the meeting consisted of an illustrated talk on the protective value of electro-deposited coatings. The talk, in the main, was in the form of commentary describing colored slides. The slides illustrated typical behavior of electro-deposited coatings under different exposures and conditions.

Southern Calif. Metal Finishing Ass'n.

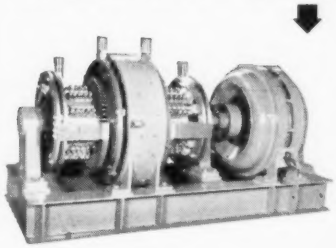
"Allocations, Priorities and Their Effect on the Metal Finishing Industry" were discussed and explained by *Walter Elieson*, Deputy Regional Director of the U. S. Department of Commerce at the October 31 dinner meeting of the *Metal Finishing Association of Southern California*.

Held in the Wedgewood Room of Carl's Viewpark Restaurant, Los Angeles, members and guests represented metal finishing shops throughout the Southern California area. The meeting was one of a series designed to provide members of the metal finishing industry in the Southern California area with factual, first-hand information on the current mobilization picture.

Introduced by Association President *E. T. Brown* (Cadmium & Nickel Plating Co.), Mr. Elieson said that his

COLUMBIA

MOTOR GENERATORS



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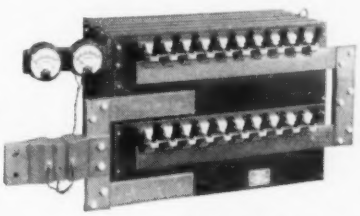
ELECTROPOLISHING

TANK RHEOSTATS



• REVERSING SWITCHES

• TONG TEST AMMETERS

Write for Descriptive Bulletins

COLUMBIA ELECTRIC MFG. CO.

4539 HAMILTON AVE. • CLEVELAND 14, OHIO

CHEMCLEAN BREVITIES

Facts Without Frills

AQUA-OFF FOR DRYING

East - Clean
Simple - Easy
Just immerse, agitate gently and remove.

The water is gone.

You need NO sawdust.

You get NO white spots, contamination, staining or residual salts.

For a SAFE BET — take a DRUM TRIAL ORDER

CHEMCLEAN PRODUCTS CORP.

Manufacturers of Industrial Cleaners, Strippers and Chemical Specialties.

Dept. M-F
64 Avenue of the Americas
New York 13, N. Y.

"We can't make all the cleaners so we make the best!"

Department has been forced to turn from the role of "helper" to that of "policeman" as a result of the controls that are being instituted.

"Conditions must get worse before they can get better," he said. "Government spending is a mere trickle as compared with what will be spent, and whether we like it or not controls are going to be with us for a long time."

Pointing out the official policy of the U. S. Department of Commerce that "civilian production must go on with the slightest interruption possible," Elieson reminded the group that the country now has full employment and we have still pledged ourselves to increase production. Included in the production objective is a sufficiency of steel and rubber for both defense and civilian purposes by mid-1952, he said.

Also included in the meeting program was an explanation of the current supply picture by *Jack Raskin* of the *L. H. Butcher Co.*, and a brief resume by *Dan Cooper* and *R. Monahan*, of Arco Insurance Service, of the group insurance plans recently adopted for the benefit of the membership by the Association.

News from California

Pennsalt Opens New West Coast Sales Office at Berkeley

R. A. Snyder

The *Pennsylvania Salt Mfg. Co.* recently announced the opening of a new sales office in the Woolsey Building, 2168 Shattuck Ave., Berkeley, Calif., to serve industry and agriculture of the western states.

Making their headquarters at the new office will be *R. A. Snyder*, who will do technical sales service work for metal and maintenance cleaners in industries of California, and *J. Cameron Siddall*, who will handle technical sales and service for agriculture in California, Arizona and New Mexico. Pennsalt's Heavy Chemical, B-K, and Laundry and Dry Cleaning Department representatives for this area make their headquarters in Los Angeles.

Mr. Snyder joined Pennsalt in 1946, and previous to his new appointment was active in the Heavy Chemicals Sales Dept. with Pennsalt at Tacoma. Mr. Snyder is a chemical engineering graduate of the University of Michigan. After graduating from the University Mr. Snyder was employed by People's Gas in Chicago, until he was called into the Army, where he served for nearly five years during World War II.

Before coming to California, Mr. Siddall was Manager of Pennsalt of Washington's Southwestern Division in Bryan, Tex., and will temporarily di-

Bright Zinc the easy way

McKeon's

Zinc-Brite

TRADE MARK REG'D.

INSURES CONSTANT PURIFICATION
through the precipitation of heavy metal impurities.

Effectively cleanses your zinc solution of copper, cadmium, lead, tin, mercury, and like contaminations as fast as they get into your electrolyte either from the anodes, work, or external sources.

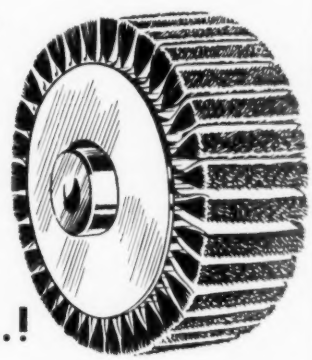
Prevents harmful accumulation of carbonates.
No filtering required. No waiting period. Economical.

CONSTANT BRIGHT PLATING WITH CONSTANT PURIFICATION

INTRODUCTORY OFFER: 1 gallon McKEON'S "ZINC BRITE" with complete set of operating instructions, enough to operate 250 gallons of solution for approximately 1 month, $3.25.

Sulphur Products Co. Inc.
Greensburg 7, Pa.

THIS MAY BE THE ANSWER TO *YOUR* FINISHING PROBLEM....!



It's the Vonnegut Brush-Backed Polishing Head—a specially designed "drum" containing 32 strips of abrasive wound on a center spool. The strips extend radially through the 32 slots around the circumference of the Head and lay back against the 32 replaceable brushes which are also evenly spaced around the Head's circumference. In operation, the abrasive "yields" to workpiece pressures, making it possible to finish or polish curved, contoured and other odd-shaped surfaces. Using the proper grit and grade of abrasive, you may find that this versatile finishing and polishing tool is just what you've been looking for. Write for Polishing Head folder.

VONNEGUT
MOULDER CORPORATION
1827 MADISON AVENUE • INDIANAPOLIS 25, INDIANA

rect activities of that sales office in addition to his new assignment. A graduate of Texas Agricultural and Mechanical College, he was formerly state entomologist for the Texas Department of Agriculture. Mr. Siddall joined the Pennsalt organization in 1946 after having prior commercial experience with the Stauffer Chemical Company in Houston, Texas. He served for four years in the Army during World War II and is the outgoing president of the Texas Entomological Society.

One of the most ambitious job plating expansion projects is underway under the direction of *Leo Atimion*, owner of *Modern Plating Works*, Inglewood, Calif.

Mr. Atimion reports that construction has started on a 28,000 square foot building to house his plating shop and also provide quarters for the *Stalder Mfg. Co.*, which he also owns, for the production of personalized belt buckles. The new plant will be located at 5400 West 104th St., Los Angeles, in the area adjacent to the Los Angeles Airport. The location will be close enough to Inglewood to permit the majority of the 125 employees, most of whom are Inglewood residents, to remain on the job.

The contract calls for erection of a $135,000 building measuring 120 x 222 feet, approximately two-thirds of which will be occupied by the plating shop. Approximately $75,000 worth of new machinery is to be acquired, Atimion reported. Upon completion, there will be approximately seven chrome tanks of 600 gallons capacity each; two hold-over and one new nickel tank, two hold-over and one new copper tank, plus facilities for cadmium, bright nickel and copper plating, high speed copper, silver and gold plating, zinc chromating work, and oxidized finishes.

Atimion has done much work in the past in plating stove tops, auto parts, and the wheeled wire baskets used in super markets. He will continue to offer specialized service in hard chrome plating and precision grinding for the oil and aircraft industries.

Atimion added the Stalder Mfg. Co. to his enterprises in 1945 and has since built up a considerable business in the manufacture of personalized belts and buckles. Equipment to be moved over from the old plant includes an oven and enameler so that the company can perform all the work in its own plant, including the soldering of emblems on the buckles.

Two former members of the staff of *Sundmark Supply Co.*, Los Angeles, have established the *California Rack Co.*, at 8686 Rheem Ave., South Gate, Calif. Associated in the enterprise are *Howard Woodward* and *Frank Robey*, who have taken factory space in the Barber-Webb Co. building. Woodward announced the firm is equipped to design and manufacture special racks for hard-to-plate items. Recoating and rack repair service are also included in their facilities.

Claimants against the *O'Connor Electroplating Co.*, of Los Angeles, whose plant blew up on February 20, 1947 were awarded judgments totaling $674,301.95 in 35 damage suits by Superior Judge Henry M. Willis at Los Angeles late in September.

The suit grew out of the explosion of the O'Connor plant which killed 17, injured 128 and caused heavy damage to surrounding property when a tank-

PARAMOUNT BRAND

FELT WHEELS ...TOPS IN Durability

Even the softest of Felt Wheels offers a durability difficult to match with any other of the commonly used fabric materials. Not only is felt tough and resistant to wear but when wear does occur, the wheel can be re-faced or re-contoured.

The net result of this durability is longer wheel life—longer *useful* wheel life. Try a Paramount Brand Felt Wheel of the proper hardness competitively. Check it against other wheels. We are confident it will show you greater earnings as measured by finished articles per wheel life.

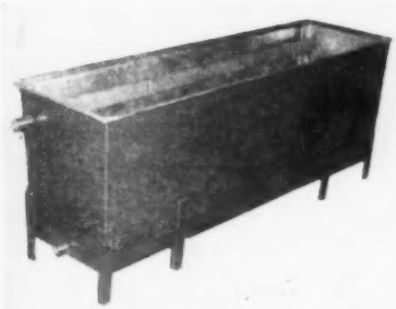
Your Supply House Can Furnish Bacon PARAMOUNT BRAND FELT WHEELS & BOBS

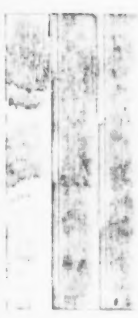
BACON FELT COMPANY

Established 1824

WINCHESTER "America's Oldest Felt Manufacturer"

MASSACHUSETTS Felt Does It Better





They Last Longer

LEAD LININGS fabricated in the Storts lead welding shop give more years of service because every seam, every connection, is thoroughly bonded with extra heavy welds that guarantee full corrosion protection and long-life utility value. Custom jobs in lead linings are a specialty here.

STORTS WELDING COMPANY INCORPORATED

38 Stone Street MERIDEN, CONN.

Manufacturers of Welded Fabrications to Specification

full of perchloric acid, into which some foreign material had been introduced, blew the plant to bits.

For personal injury and property loss, Judge Willis ordered payment of $111,896.56, and in addition, insurance reimbursements amounting to $562,405.39. During the hearings, which started on July 26 and closed on September 7, it was disclosed that the only actual asset of the concern is $50,000 in insurance, plus some $5,000 worth of salvaged material. It is expected that the claims will be apportioned in further court proceedings.

R. E. Sanderson has been appointed factoy representative for northern California for *McColpin-Christie Corp.*, of Los Angeles, manufacturers of rectifiers and battery chargers. His headquarters are in San Francisco. Sanderson has been associated with the firm for ten years as advertising manager and regional sales manager.

Leslie E. Heene, formerly of Waterbury, Conn., where he has been a member of Waterbury Branch of the AES for a number of years, has joined the shop staff of *Liberty Plating Co.*, Los Angeles. His plans are to transfer his AES membership to Los Angeles.

John K. Trotter has been named production manager of the Los Angeles factory of *Cannon Electric Development Co.*, succeeding *Richard L. Rowen*, who recently was elected vice-president. *Anthony Slanga* has resigned as company comptroller and has been succeeded by *Ray O. Hill*.

Chase Brass & Copper Co. has announced appointment of *Raymond A. Sternthall* as Los Angeles Branch Manager, replacing the late *T. F. Day*, who died in July.

Surface Alloys, Inc., 2972 East Century Blvd., Los Angeles, has consolidated its electroplating activities in a new plant at 5835 West 98th St.

United States Spring & Bumper Co., of Los Angeles, has acquired Fether & Company, Santa Clara, Calif., and will operate it as its brake division.

Coleman-Patterson Corp. has opened a new plant at 2053 West 38th St., Vernon, Calif., for the production of wire and metal products.

Richards Rack Co., 643 Santa Fe Ave., Los Angeles, has completed an expansion program which doubled the floor area of the plant, and has also added considerable new machinery. *R. A. "Al" Richards*, president, reports. Two punch presses, a lathe and a drill press were added to holdover equipment used in the manufacture of anodizing, hard chrome and plating racks.

Kasmir Tarczynski, shop foreman of the *S. & M. Lamp Co.*, Los Angeles, reports that the firm has added a new zinc barrel plating setup to its finishing room equipment. The firm was organized in 1909. It does all its own fabrication from raw material, doing the shaping, forming, pressing, spinning and finishing in its own plant at 119 West 36th Place, Los Angeles.

Marcus Rynkofs, owner of *Liberty Plating Co.*, Los Angeles, and a charter member of Los Angeles A.E.S.

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NEVER DUPLICATED

THE Airflow BUFF*

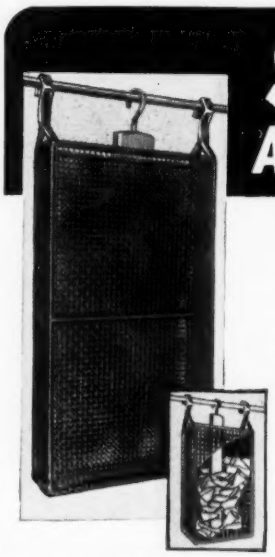
MANUFACTURED EXCLUSIVELY BY

UNITED BUFF PRODUCTS CORP.
233-241 OAK STREET
PASSAIC, NEW JERSEY

For prompt delivery at nominal prices call your local representative.

If not available in your territory, contact our home office.

*Patent No. 2,519,275. Other patents pending.



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Utilize valuable anode scraps with BELKE Anode Baskets. Merely suspend an anode in center of basket and pour anode scraps in around it.

Built for long service, BELKE Anode Baskets are ruggedly constructed of heavy gauge, steel wire-mesh reinforced with frame of welded steel rod. Heavy coating of BELKE Universal Plastic assures protection against all plating solutions.

Made to specified dimensions. For quotation send length, width, and depth of basket you require—or ask your BELKE Service Engineer.

BELKE DIPPING BASKETS—Wire or perforated sheet metal construction in round or rectangular shapes—of steel, stainless steel, aluminum, Monel, Nichrome, copper or brass—uncoated or coated with BELKE Universal Plastic. Many standard sizes, or can be made to order. Write for prices.

Belke MANUFACTURING CO.
947 North Cicero Ave.
Chicago 51, Ill.

EVERYTHING FOR PLATING PLANTS

Branch, brought to the November 8 meeting a program of the branch's early-day educational session which revived nostalgic memories in the minds of old-timers present. The booklet was the "Program of the 2nd Annual Assembly of Los Angeles Branch, A.E.S.", held October 18, 1930, at Westgate Lodge Hall in Los Angeles.

Some of the men whose names appeared in that two-decade old program are still members of the Branch. Others have dropped their membership or passed on. Here are some of the names: R. Gripp, E. W. Francis, H. G. Coombes, H. B. Bailey, Don M. Bedwell (1951 A.E.S. convention chairman), P. A. Boeck, B. C. Gardes, J. R. Delaney, R. J. Lucke, John L. Merigold, M. McNulty, W. R. French, O. Worthington, F. D. Hyde, C. B. Morris, O. J. Pendley, J. Corbit.

A visitor to Los Angeles on a business trip in November was *T. D. Hinchcliffe*, of Industrial Filter & Pump Mfg. Co., Chicago.

A. C. Sammonds, head of Aero Supplies of Los Angeles, reports that a new branch plant is being erected for the firm in the Los Angeles airport industrial district.

OBITUARIES

FRANK C. RUSHTON

Frank C. Rushton, 68, honorary life member of the American Electroplaters' Society, father of The Los Angeles Branch and collaborator in the founding of four other AES branches, died October 18 at the Sawtelle Military Hospital, West Los Angeles, Calif.

Mr. Rushton had been confined to the Military Home for the past several years with a recurrence of the ailments that were the result of the severe gassing he sustained in France during World War I.

Funeral services were held on Saturday, October 21. Members of Los Angeles Branch were pallbearers.

Mr. Rushton was a member of the AES for more than 40 years. He collaborated in the organizing of St. Louis Branch and served as its secretary in the pre-World War I days. He served with distinction in the A.E.F. in France during the first World War and it was during this service that he was gassed so severely that serious lung impairment resulted, from which he suffered intermittently during the next 30 years.

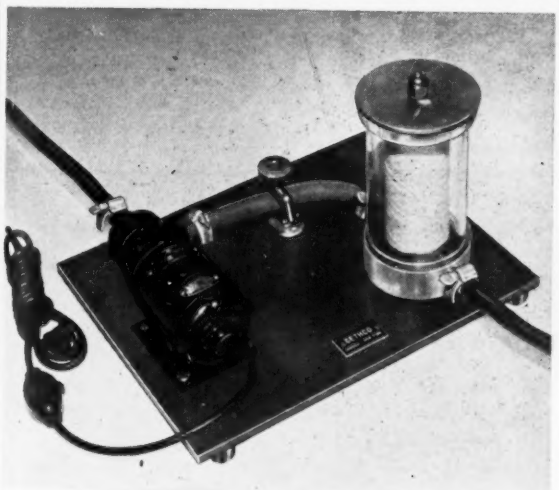
CLARENCE G. SPENCE

Clarence G. Spence, 66, owner of Spence Electro Plating Co., and known as "The Flying Plater of Los Angeles," died October 26 at Tule Lake, Calif., as a result of a heart attack suffered on a duck hunting trip.

Mr. Spence was born August 7, 1884, at Brighton, Ill. During the early years of the century he served as a striper and decorator for the St. Louis Car Co. in St. Louis, Mo. This firm, in 1905, sent him to South America to direct the lettering and decorating work in connection with the first streetcar system installed in Rio de Janiero, Brazil.

He came to Los Angeles in 1908, where he operated several restaurants and served for some years as a scenic

SETHCO SEZ . . . Throw Away Your Funnels and Filter Paper



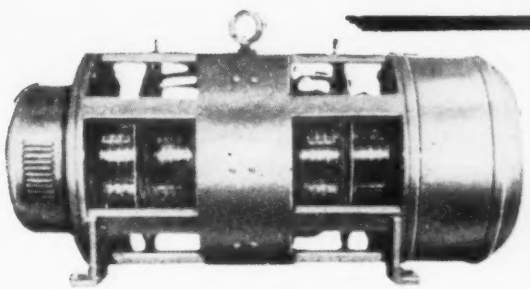
MODEL LSU-5

- **APPLICATION** — Filters all electroplating solutions.
- **CONSTRUCTION** — High temperature lucite filter cylinder. Highest quality stainless, type 316, pump & fittings.
- **ECONOMICAL** — No loss of expensive solutions, complete drainage.
- **CAPACITY** — 50 gals/hr : Open pumping—400 gals/hr.
- **FILTER TUBE** — Easily rinsed or back washed.
- **COST** — ½ price of Sethco's other high quality low priced units.

WRITE TODAY FOR DESCRIPTIVE LITERATURE
SETHCO, 105-07 150 ST., JAMAICA 4, N. Y.

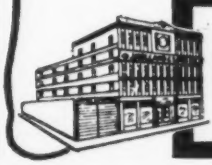
HOLLAND SAYS:

NOW IS THE TIME TO REPLACE THAT OLD GENERATOR



• *Motor Generator Sets in all sizes* •

Write for FREE Folder "P" showing our wide selection of Metal Finishing Equipment.



J. HOLLAND & SONS, INC.
MANUFACTURERS • DEALERS
274 SOUTH NINTH ST. • BROOKLYN, N. Y.

painter in the early movie industry. He entered the enameling business in 1920 when he founded Western Enameling Co. in Los Angeles, later adding electro-plating facilities. He built the present plant at 528 East 15th St. in 1926 and has operated since then as the Spence Electro Plating Co.

Mr. Spence was a member of the American Electro-Platers Society and the National Association of Metal Finishers, serving as local president of the latter organization in 1946-47. He was an ardent sportsman, with hunting and flying as his particular hobbies.

Surviving are the widow, Mrs. Clara G. Spence, and a sister, Mrs. George Rogers.

Manufacturers' Literature

Filter Units

Belke Mfg. Co., Dept. MF, 947 Cicero Ave., Chicago 51, Ill.

A bulletin published recently by this firm illustrates and describes a line of plating solution filter units utilizing either the vertical or horizontal plate filtering principles. The advantages of each type are outlined, and cutaway views show the working principles of these units. Copies of the bulletin may be obtained by writing to the above address.

pH Test Papers

Paul Frank, Dept. MF, 118 E. 28th St., New York 16, N. Y.

A new bulletin issued by this firm describes the various test papers for measuring the pH of plating solutions, pickling baths, etc. The test papers are boxed, 200 strips per box, and may be obtained to cover the pH range from 0.4-13.1. Copies of the bulletin are available on request.

Power Brushes

Osborn Mfg. Co., Dept. MF, 5401 Hamilton Ave., Cleveland 14, O.

This firm has just published a bulletin describing their line of Heli-Master power brushes for heavy duty industrial cleaning, finishing, and scrubbing. The brushes are available in a wide range of materials, in diameters up to 35" and lengths (face widths) up to 180", and with many types of arbor holes. Surface speeds up to 10,000 r.p.m. may be used for rapid effective cleaning and scrubbing in many types of industrial operations. Copies are available upon writing to the above address.

Motor-Generator Booklet

General Electric Co., Dept. MF, Schenectady 5, N. Y.

A new eight-page, two-color booklet on synchronous motor-generator sets has been announced as available from the above firm.

Designated as GEA-5506, the publication covers motor-generator sets from 30 to 8,000 kw. as a source of d-c power for industrial applications.

Well illustrated, the booklet shows four typical installations and describes the construction features of the synchronous motors and d-c generators. Motor rating include 60, 50, and 25 cycles, 0.8 pf., 220 to 13,200 volts. Generators, both shunt and compound wound, are rated 125, 250, and 600 volts.

BARREL PLATING •
Daniels Plating Barrel & Supply Co. engineered and developed the well known O L S type Plating Barrel. Over 30 years of experience are behind the Daniels plating equipment.

PRODUCTION •
O L S Plating Barrel, due to positive contact design — simple construction — current is carried directly to the work. Does more work per day. Faster action. No overhead devices. No solution dumping. Economical, more profit.

MAINTENANCE •
Daniels O L S Plating Barrel requires little maintenance. It has few replaceable parts, and they are inexpensive.

Equipment made to meet all Production Requirements

DANIELS PLATING BARREL & SUPPLY CO.
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DANIELS Electroplating and Polishing Equipment and Supplies
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FROM
Naraco Racks

Season's Greetings
With Best Wishes For
The Coming Year

Serving Eastern Industrial Area
National Rack Company, Inc.
356 River Street — Paterson, N. J.

Serving Midwestern Industrial Area
Imperial Plating Rack Co.
163 Industrial Avenue — Flint, Michigan

Polishing & Buffing Compounds and Wheels

Schaffner Manufacturing Co., Inc., Dept. MF, Schaffner Building, Emsworth, Pittsburgh 2, Pa.

The above firm, manufacturers of a complete line of polishing and buffing compositions, buffs and platers' supplies, have just announced the release of their new Catalogue No. 51, loaded with the latest methods on polishing, buffing and coloring compound for the industry as well as complete speed charts for buffing wheels, and charts designating the proper composition to be used on the various metals for the proper finish desired.

This new, up-to-the-minute catalogue is also a buffing and polishing consulting dictionary, and it may be had free of charge by writing.

Rubber Lined Steel

Metalweld, Inc., Dept. MF, 2600 Hunting Park Ave., Phila. 29, Pa.

An illustrated bulletin (4 pages) entitled "Rubber Linings" describes rubber-lined steel for the transporting, storing and handling of corrosive chemicals. The B. F. Goodrich Vulcalock bonding process with bond strength of over 500 lbs. psi., is used. Lining is bonded permanently. Table lists common corrosives for which rubber-lined tanks can generally be recommended.

Filter Pump Units

Sethco, Dept. MF, 105-07 150th St., Jamaica 4, N. Y.

This firm announces a new six page brochure on its line of small, stainless steel filter pump units. The brochure is fully illustrated and includes technical as well as descriptive data and prices.

Heli-Master Power Brushes

Osborn Mfg. Co., Dept. MF, 5401 Hamilton Ave., Cleveland, O.

A new four-page booklet describing their recently developed line of Helimaster power brushes is being offered by the above firm.

Complete instructions for ordering and specifications for use are included. Inserted in each booklet is an Application Data Sheet which can be filled out by a company having a cleaning, scrubbing or finishing problem which could be solved by brushes. This sheet gives, in blueprint form, all the dimensions of a brush installation, and asks such questions as would pertain to the use of the brush, speed of machine, type of solutions used, etc.

This booklet is offered free on request by writing to the above address.

Manual of Instrument Transformers

General Electric Co., Dept. MF, Schenectady, N. Y.

A profusely illustrated, 76-page manual, GET-97A, covering the theory of operation and the application of instrument transformers has been announced as available by the above firm's Meter and Instrument Divs.

Priced at $1.00, the new Manual of Instrument Transformers is written for practicing engineers and students engaged in the fields of power generation, transmission and application where metering and relaying problems can be solved by the correct application of instrument transformers.

The manual covers the basic fundamentals of instrument transformers,

RINSE-CLEAN

ELIMINATES — Spots, Stains, and Streaks on plated and acid-dipped work.

NON-VOLATILE — Long lasting. Dries work quickly. Effective in hard or soft water, and water containing *iron, chrome, nickel, and copper* salts. New principle inactivates these salts.

LEAVES — Work bright and helps prevent tarnishing. Subsequent recoloring eliminated.

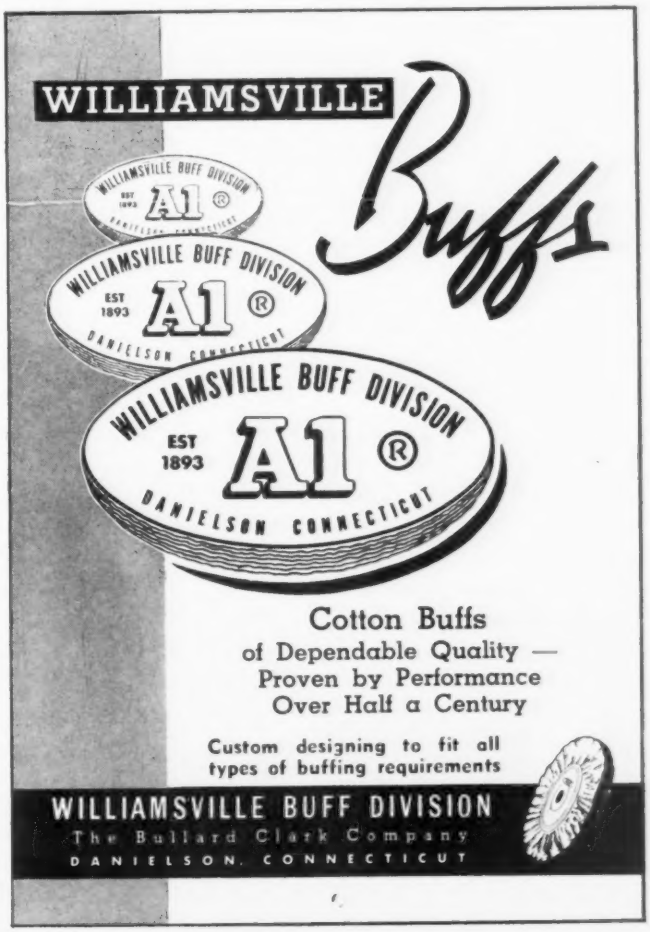
ECONOMICAL — 1/8 to 1/4 oz. of RINSE-CLEAN per gallon in *final* hot rinse. Saves labor and drying material.

YOU — Should try a 10-lb. trial sample for $6.50, f.o.b. N. Y. C.

By the makers of ENLEY POLYETHYLENE LINERS

ENLEY PRODUCTS, INC.

254 PEARL ST. NEW YORK 7, N. Y.



such as accuracy standards, insulation and polarity. In addition, it gives complete information on potential and current transformers, including operating principles, types and ratings, applications, circuits, fusing, etc.

A chart for selecting the proper transformers for a specific application and a bibliography covering various phases of instrument transformer operation, design, application and performance also are included.

Improved Filters

Belke Mfg. Co., 947 N. Cicero Ave., Chicago 51, Ill.

A new bulletin just published by this firm gives complete information on improved Belke filters, which have a new slurry-tank design as well as recently developed Lucite filter plates. Information on Type-A filters for acid solutions and Type-C filters for cyanide solutions is included. Both horizontal plate and vertical plate models are described.

Copy of Bulletin 1247 will be furnished promptly on request.

Blast Cleaning vs. Pickling

American Wheelabrator and Equip. Corp., Dept. MF, 1752 South Byrkit St., Mishawaka, Ind.

"How Wheelabrator Blast Cleaning Solves Acid Pickling Problems" is the name of a new bulletin now available from this firm.

The story of how this airless blasting process has influenced cleaning speeds, costs, safety, etc. and how it eliminates acid disposal in certain applications is told in case study form.

A free copy of Bulletin No. 584A may be obtained by writing directly to the above address.

Corrosion-Resistant Materials Selection Chart

The Cooper Alloy Foundry Co., Dept. MF, Hillside, N. J.

This firm announces the publication of a four page folder entitled *Materials Selection Chart*. Prepared by *Norman S. Mott*, Chief Chemist and Metallurgist at Cooper Alloy, this chart is designed for those interested in the selection of the most economical material satisfactory for resistance to corrosive media.

Carbon steel, along with the more expensive materials, Cooper alloy 17S (ACI CF-8), Cooper alloy 17SM (ACI

FOR PLATERS, SILVERSMITHS, JEWELRY MANUFACTURERS, DENTAL LABORATORIES, ETC.

Supplied in brass, steel, or nickel silver wire in sizes .0025-.006 or bristle, nylon or fibre
Special sizes and shapes to order.
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GUARANTEED
STEEL BALLS
Best for Burnishing . . . Perfect for Polishing. No culls, no cracks.
Mixtures as Required
THE HARTFORD STEEL BALL CO.
HARTFORD 6, CONN.

SOMMERS BROS. MFG. CO.
MFRS. OF "BEACON"
Plating and Polishing Supplies and Equipment —Complete Semi and Full Automatic Installations—Gold, Silver and Chrome Rouge, Stainless Steel and Satin Finish Compounds—Buffs, Polishing and Felt Wheels.
WRITE FOR PRICES
3439 NO. BROADWAY
ST. LOUIS 7, MO.

Attach this ad to your letterhead and receive our new 1951 Buffing Compound and Supplies Catalog.

AURALITE
TRADE MARK
The Original Water Soluble Gold Alloy Salt
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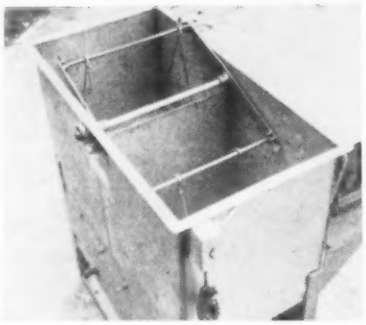

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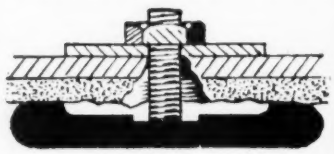

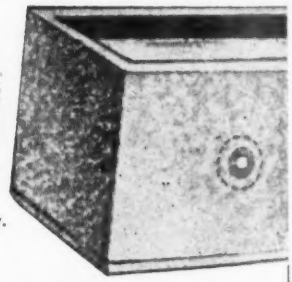

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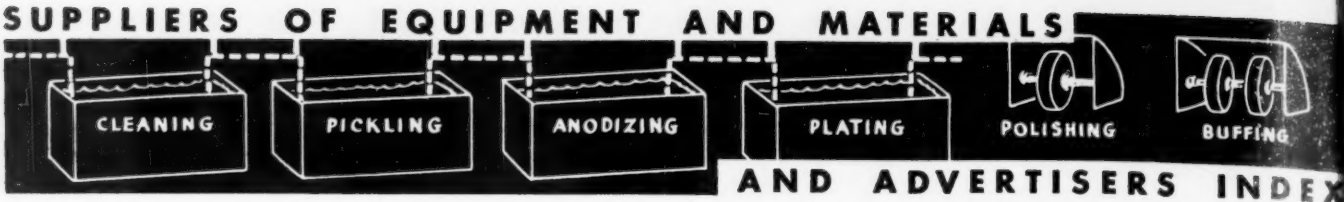

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